AFSWP Report #717

UNITED STATES NAVY

REPORT ON PHASE II
of the
PRESSURE-HEIGHT PREDICTION PROJECT
VOLUME II

DESCRIPTION OF CONTOUR PATTERNS AT 500 MILLIBARS

PROJECT A-R-O-W-A

Bureau of Aeronautics Project Arowa (TED-UNL-MA-501)
"Applied Research; Operational Weather Analysis"
(AROWA)

U. S. Naval Air Station
Building R-48
Norfolk, Virginia

April 1954

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DESCRIPTION OF CONTOUR PATTERNS AT 500 MILLIBARS

by

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BUREAU OF AERONAUTICS PROJECT AROWA
BUILDING R-48
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NORFOLK 11, VIRGINIA

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ABSTRACT

Using historical and newly-devised models this paper presents results of an attempt to define and describe objectively patterns of the geostrophic flow at the 500-mb level. Emphasis has been placed on such large-scale, slowly developing aspects of hemispheric contours as long waves, blocks, and cycles in the strength of the zonal wind.

The exact location and intensity of long waves in terms of their departures from normal are shown on a space-averaged mean chart and changes in these particulars illustrated in successive charts as changes in height.

Measurements on mean charts have been utilized to define "blocking" numerically and thus furnish this heretofore illusive feature with a continuity both spatial and temporal.

Zonal profiles have been analyzed in accordance with a new and objective method, herein outlined, which is based primarily on the departures from normal values of the geostrophic wind. Relevant "normal" values are provided.

By way of illustration these proposed techniques have been applied to hemispheric patterns for March of this year. An evaluation of the time, data, and manpower required shows these techniques to be practical for even the smaller meteorological unit.

Finally, an outline of research now in progress is included.

PREFACE

The research problems assigned Project AROWA reflect the interest of the U. S. Military Forces in all areas of the Northern Hemisphere. In addition, recent trends in forecasting emphasize the necessity for considering large-scale features of the hemispheric circulation. This paper intends to set forth a practical method by which large and small meteorological units may obtain this essential information.

The report was prepared at Project AROWA by Captain F.A. Berry, USN, and Lieutenant Commanders W.H. Haggard, USNR, and P.M. Wolff, USN. Its completion would not have been possible without the assistance of the Project's crew, which prepared the data and made the numerous analyses required. The data was processed at the National Weather Records Center and the cooperation of Messrs. Leslie Smith, Raymond L. Joiner, and Daniel O. Harton who provided valuable suggestions is appreciated. The manuscript was edited by R.A. Corvo.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

I. INTRODUCTION

In published studies of upper patterns historically clear definitions have not been the rule. Even those terms for synoptic phenomena which have appeared frequently in the recent literature have not been defined objectively or numerically. While descriptions of such surface features as "highs," "lows," and "fronts" are now standardized, those of upper-air systems, "long waves" and "blocks," for example, have varied with each investigator. Therefore this study must begin with definitions, both verbal and graphic, of the models in which the patterns are to be described.

Riehl (1) has put forth the sound concept that objective numerical methods must be the aim of meteorologists if a forecast of uniform quality is to be achieved. In his forecasting routine, however, this aim has been only partially achieved. Such problems as the location of long waves and the determination of the index cycle stage are only qualitatively discussed, and other fundamental considerations, such as the changes in intensity of long waves and the variation of the existing cycle in zonal westerly strength from normal, barely mentioned.

The purpose of this study is to devise a system for describing objectively and numerically a 500-mb chart, so that the features of a later chart might be more easily determined in advance (by methods

either already in use or which might be developed.)

Long steps have been taken in this direction with the procedure suggested here. The following sections of this paper will describe in some detail those lines of reasoning pursued to arrive at a specific method of analyzing each possible feature of a chart and will summarize that method presently considered best applicable to each.

II. SYNOPTIC MODELS

Simplified models will best serve to characterize numerically patterns varying so greatly in detail as those at the 500-mb level. In this study, the model employed is basically that of two superimposed wave patterns. Slow-moving features designated as long-wave troughs and long-wave ridges lie under a system of fast-moving disturbances designated as short-wave troughs and short-wave ridges.

1. Short Waves

The contours of a given 500-mb chart will be punctuated by numerous troughs and ridges of small dimension. These trough and ridge lines (connecting points of maximum curvature) are called short-wave troughs and short-wave ridges. Their relation to other meteorological parameters is often quite marked, as in the case, for instance, of the coincidence of 24-hour height-fall centers with short-wave troughs and that of 24-hour rise centers with short-wave ridges. Evident also are correspondencies less consistent but sufficiently frequent to warrant attention, such as that between short-wave troughs and surface lows.

Figure (1) and (2) show a 500-mb chart with the short-wave troughs and ridges indicated; in Figure (1a) and (2a) the relation between these lines and 24-hour height changes is plain.

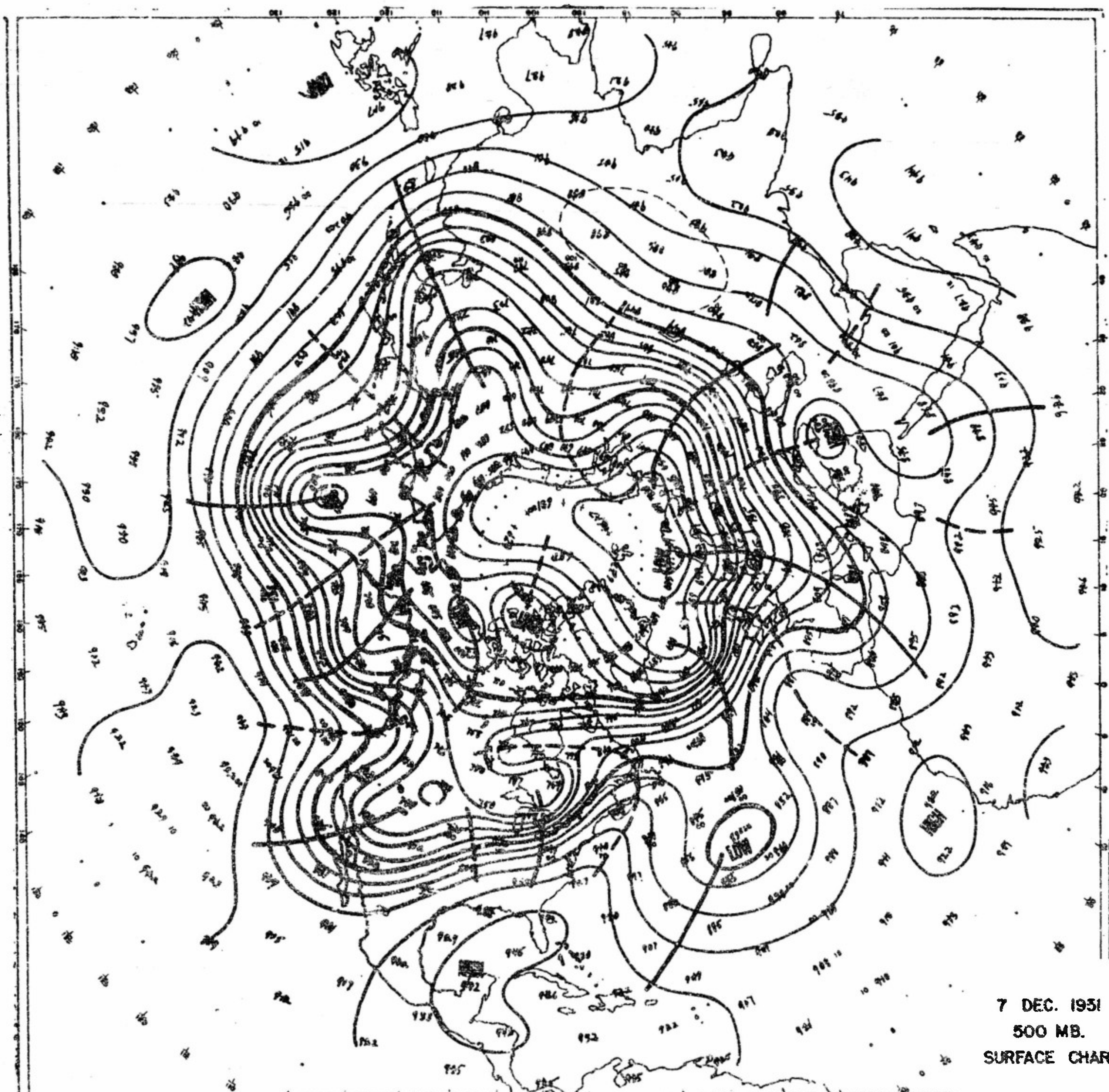


Figure (1). 500-mb Contours for 7 December 1951
Short-Wave Trough and Ridge Lines

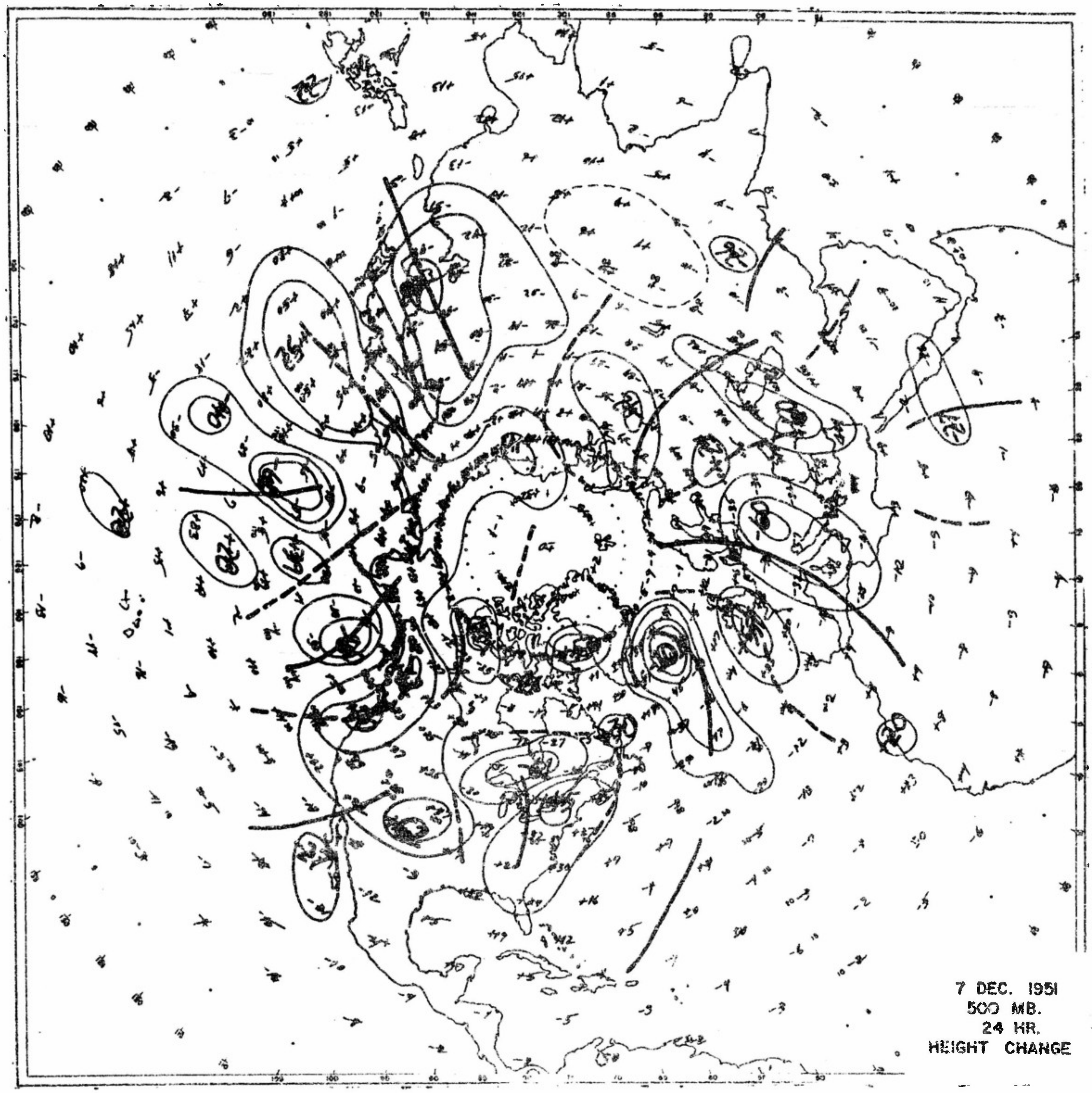


Figure (1a). 24-hr Height Change from 6 to 7 December 1951
Short-Wave Trough and Ridge Lines

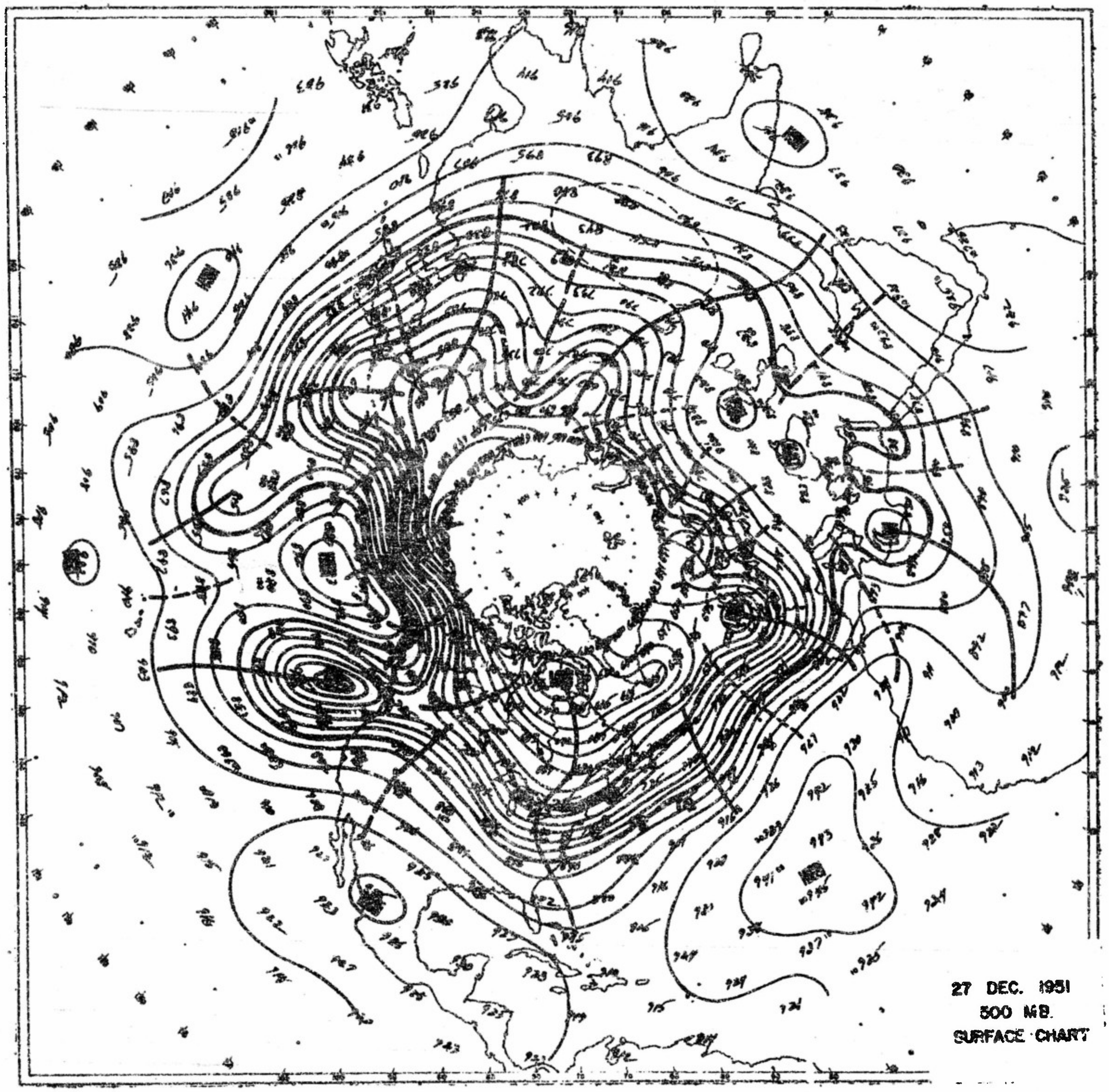


Figure (2). 500-mb Contours for 27 December 1951
Short-Wave Trough and Ridge Li...s

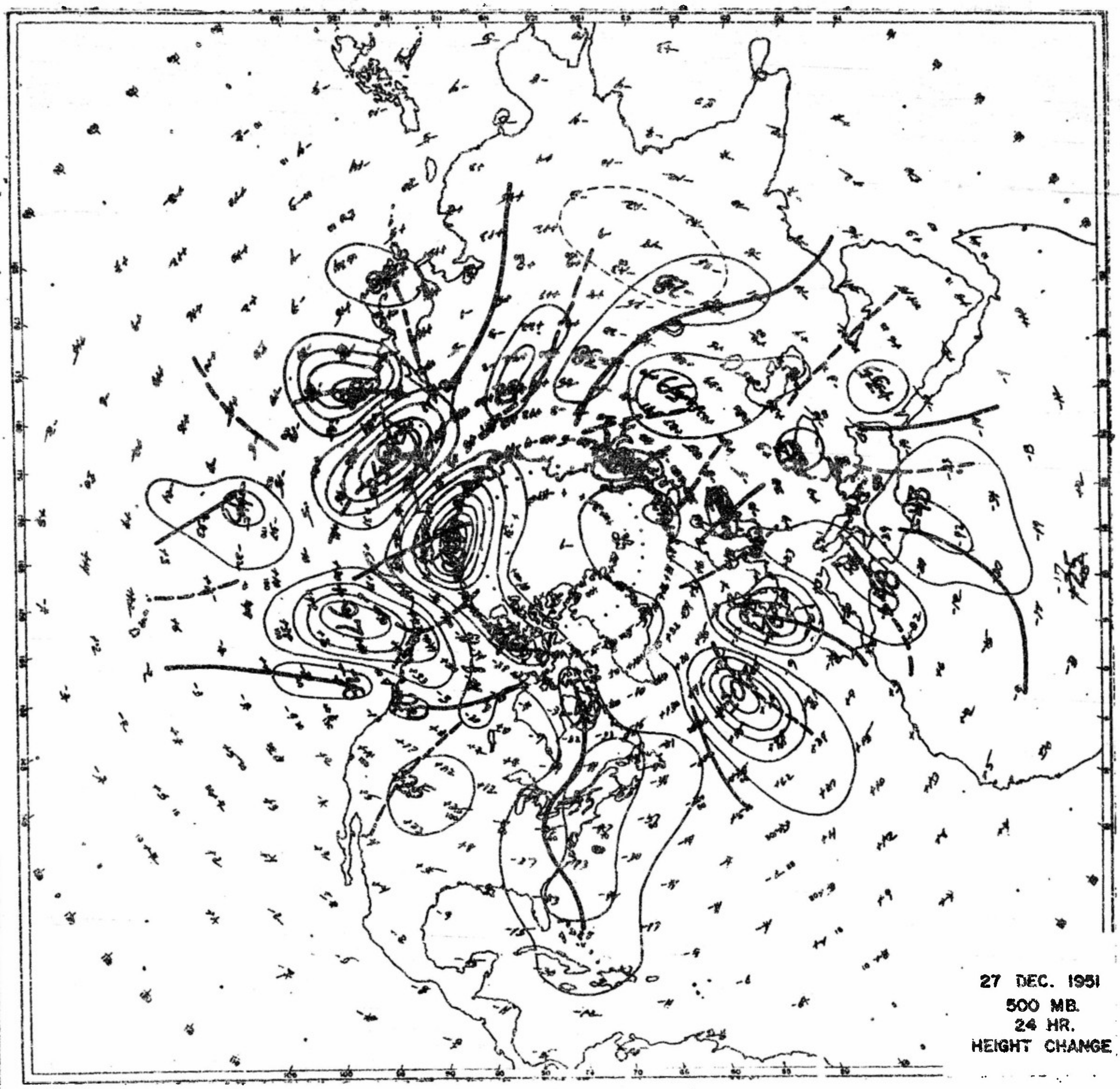


Figure (2a). 24-hr Height Change for 27 December 1951
Short-Wave Trough and Ridge Lines

Figures (3) through (5) illustrate common instances of the relation of short waves to other synoptic features. Note that in Figures (4) and (5) the slope is a function of the baroclinity and varies from near zero in the Mediterranean, where cold air masses are not present, to 8-10° Longitude off the eastern coasts of the United States and Asia.

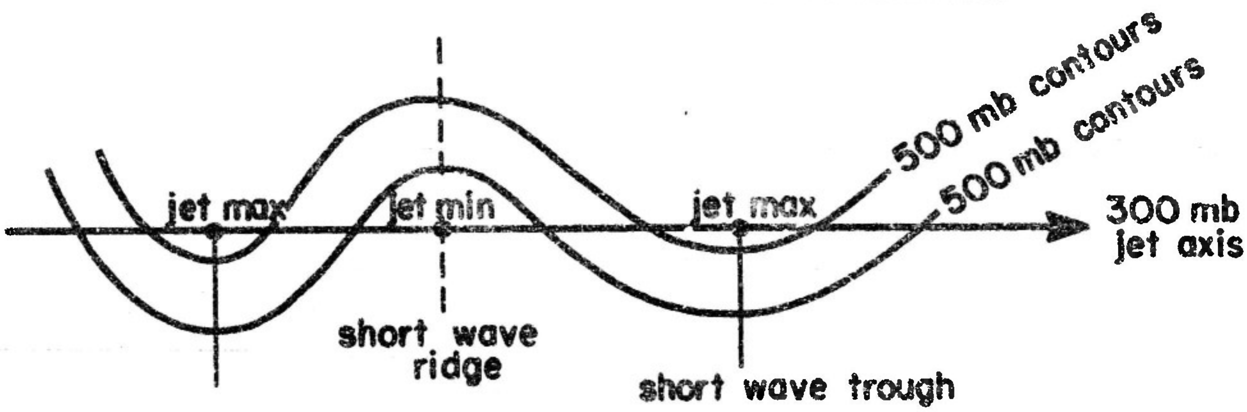


Figure (3). Short Waves and Jet Wind Speeds

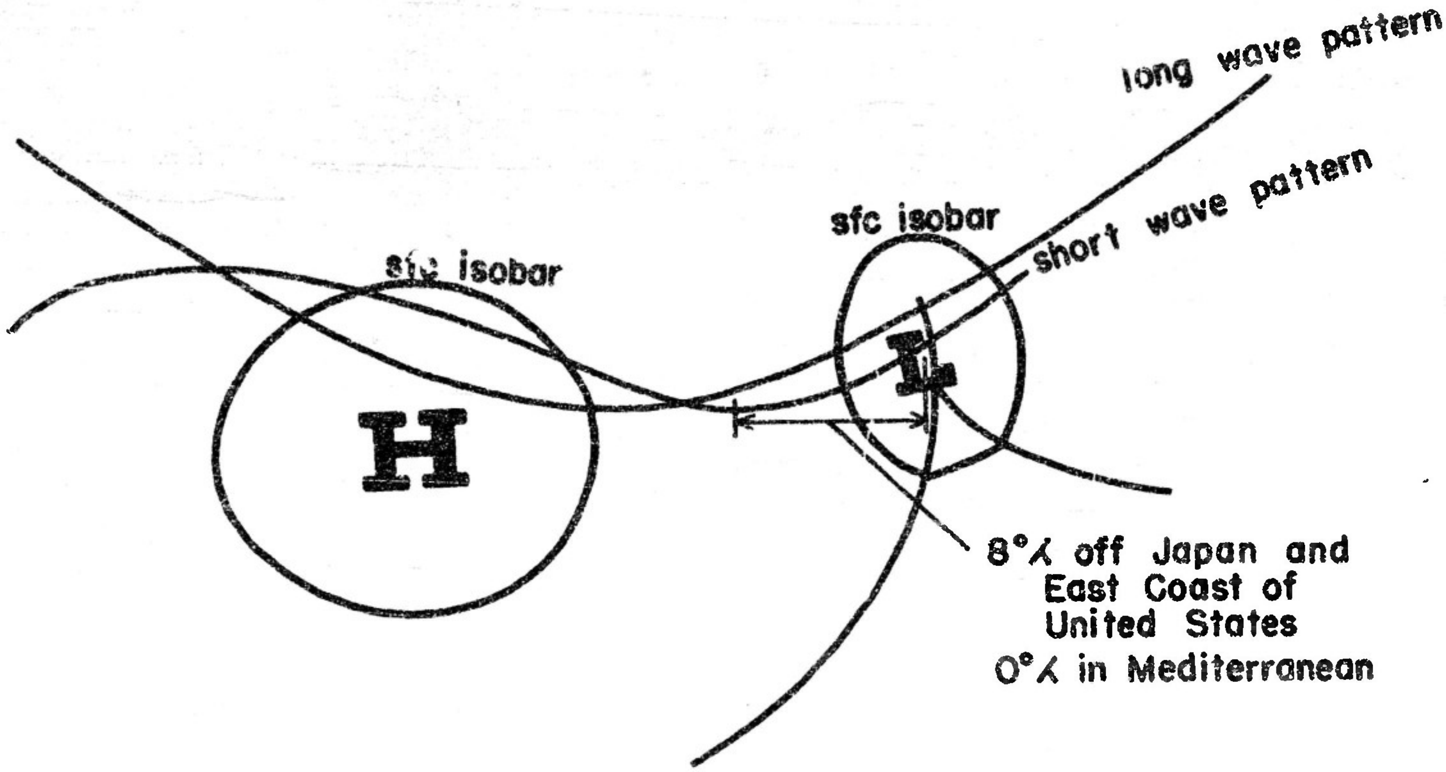


Figure (4). Short Waves, Long Waves, and Surface Features

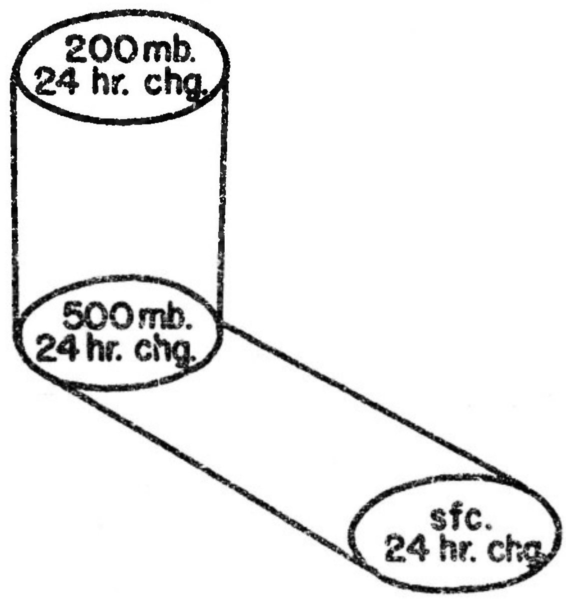


Figure (5). Slope of 24-hr Height Change Centers

This list is not exhaustive; certain thermal relations generally recognized, such as concern cold lows and warm lows, have not been included. Of course, not all the correspondencies noted will be present in every chart, but their frequency is such as to preclude any doubt as to their relevance to synoptic analysis.

III. LONG-WAVE ANALYSIS

The long-wave concept postulates the existence of from 3 to 7 sinusoidal perturbations in the hemispheric flow at higher levels.

1. Historically

Following publication of Rossby's work (2), the theory of long waves has been sporadically employed, particularly in making forecasts in those synoptic situations where simple extrapolation does not suffice. Despite its relative longevity, however, the concept has remained remarkably unclear. The chief reasons for this limited utility have been (1) the impossibility of determining the position of a long wave by inspecting a single synoptic chart, and (2) the lack of a method for objectively determining the intensity of the wave. As a result, in all but the simplest situations two meteorologists working independently would produce substantially different long-wave analyses.

A recent paper by the authors (3) outlined a method of using tracks of 500-mb height change centers to indicate the position of long waves. Unfortunately, this method has only a qualitative value and falls far short of a practical objectivity.

2. Relation to Synoptic Events

The grosser aspects of the long-wave patterns (representing the mean atmospheric flow) are stable both temporally and spatially: a

deep long-wave trough or intense ridge will continue stationary and only slightly modified over a period of 24 or 48 hours; a deep long-wave trough observed over the eastern United States will invariably be flanked by two long-wave ridges. This double stability often characterizes even larger intervals of time and space throughout the hemisphere. Obviously, a working knowledge of these conditions is of prime importance in long-range prediction and in the extrapolation of patterns in areas of sparse data.

Figures (6) and (7) are included to show the relation of other meteorological events to the long-wave trough and ridge pattern. Figure (6) shows the classical view of these interrelationships, and Figure (7) the same parameters from an actual five-day period.

The long-wave system, then, provides general guidance in prognosticating surface events. Used alone, however, it gives as misleading a result as would be gained, say, by judging the motion of a cyclone on the basis of steering principles only.

3. Time Mean Charts

Namias (4) made a valuable contribution to this analytical problem by discussing as long waves the troughs and ridges present on 5-day time mean charts at the 700-mb level. For the purposes of this study 5-day time mean charts have been prepared in quantity for the 500-mb level. In general, they portray the mean flow quite

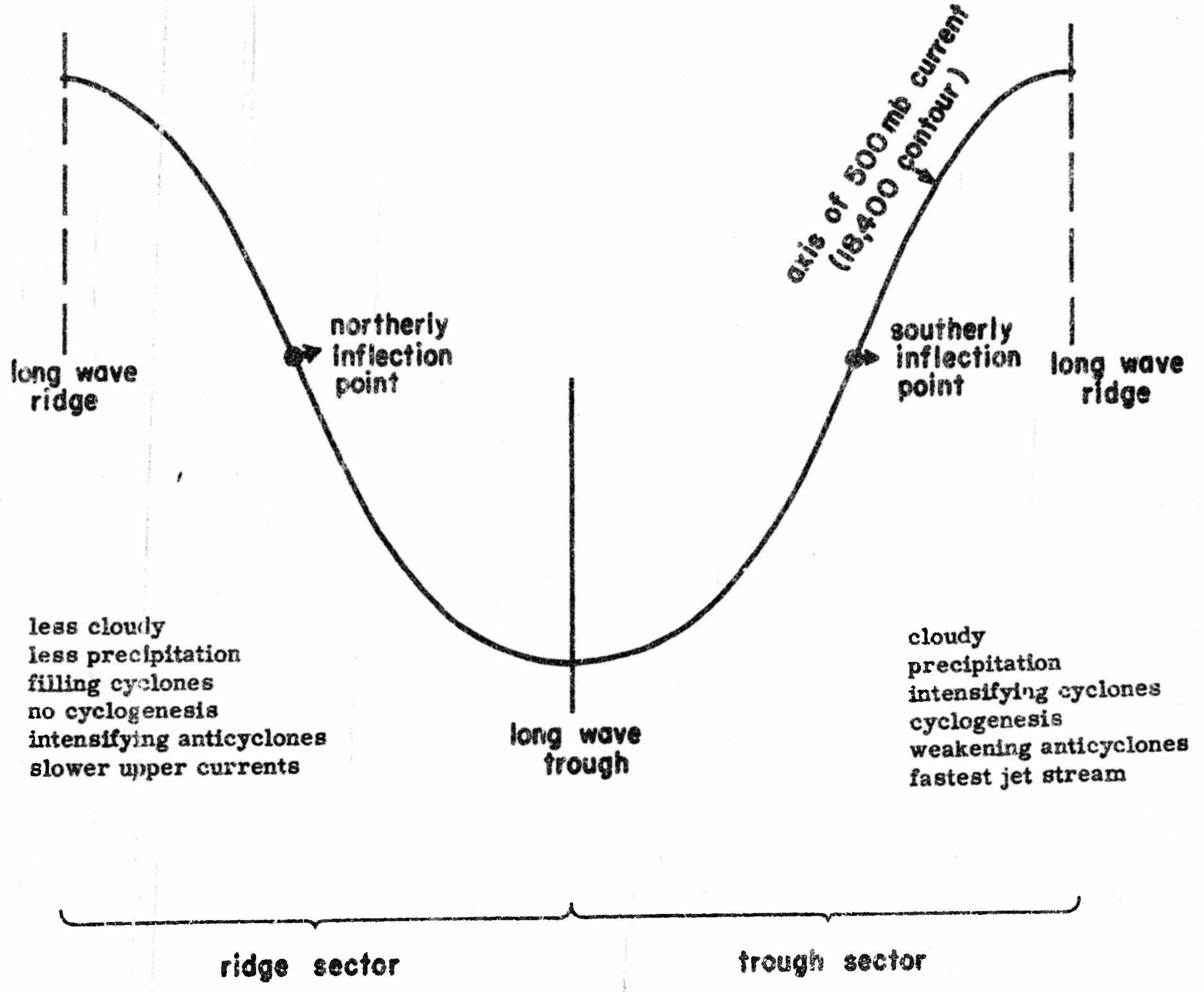


Figure (6). Theoretical Coincidence of Long Waves and Other Meteorological Events

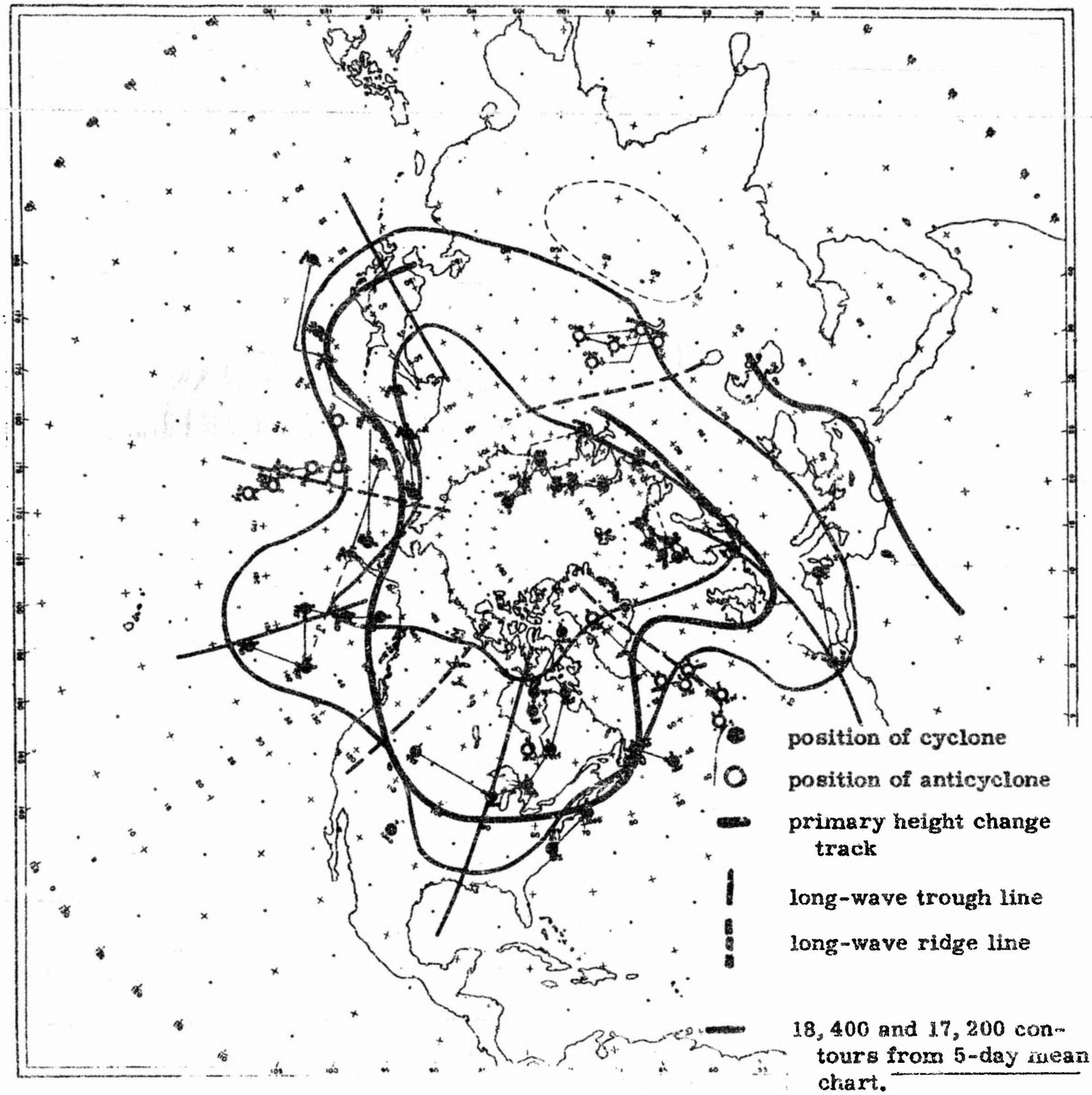


Figure (7). Actual Illustration of Long-Wave Pattern and Other Meteorological Events for a 5-Day Period.

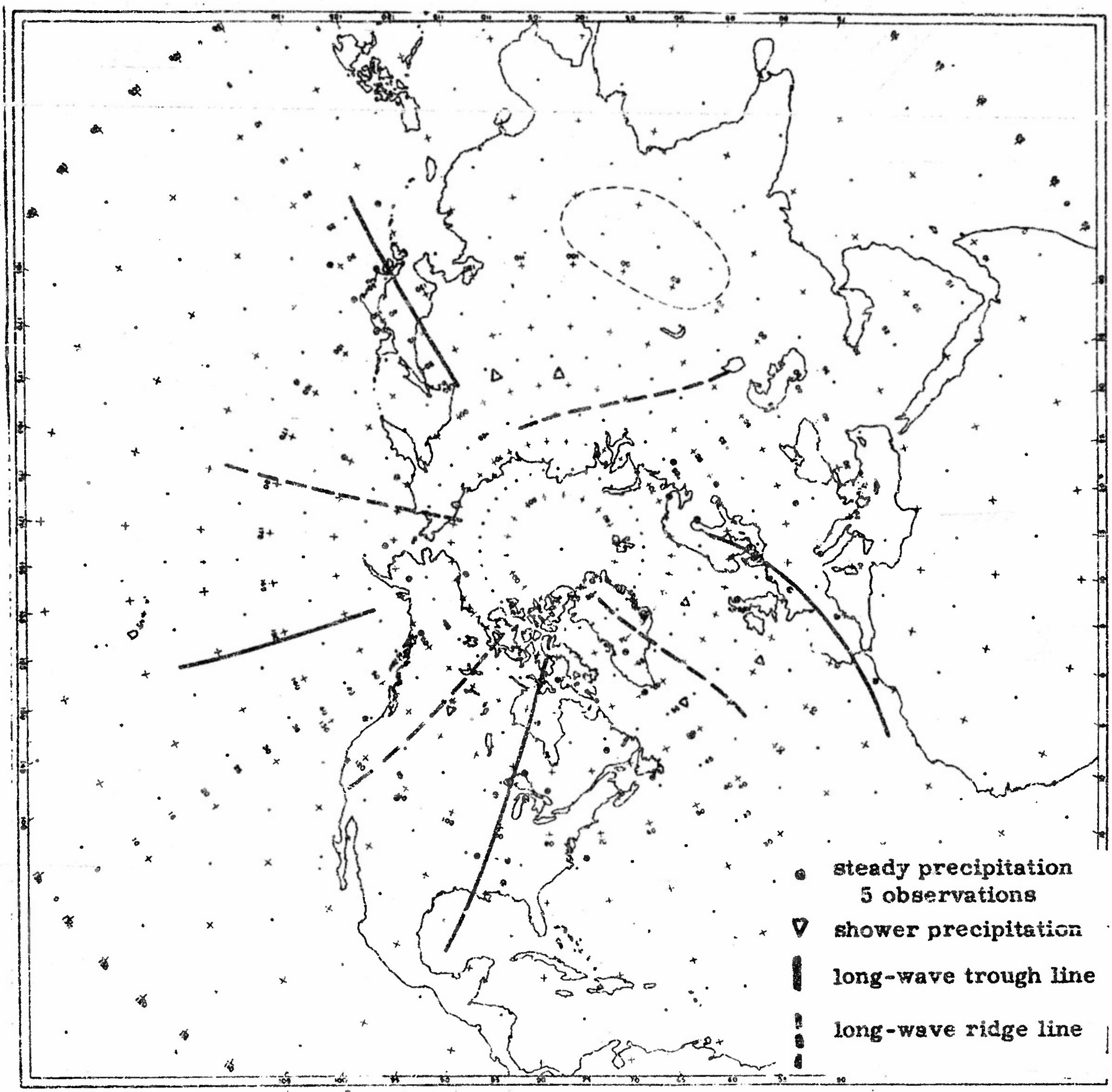


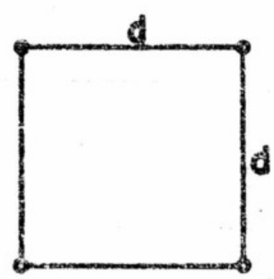
Figure (7a). Long Waves and Precipitation

satisfactorily and can be recommended for use in historical research.

Since this method inevitably involves a time-lag (the last available 5-day mean is 2 1/2 days old when prepared), its operational value is severely restricted. Attempts to bring the time mean up to date either by applying various forecasting procedures or by using a system of "normal" heights have not been successful.

4. Space Mean Charts

A powerful concept, that of the space-averaged mean chart, has been introduced into the literature recently by Fjortoft (5). The daily height value of a given point is replaced by the mean of heights at the outer boundaries of an area surrounding the point; the resulting mean flow, advecting the effects of smaller scale features, shows smoothed contours. Fjortoft recommends the use of a square grid approximately 12° of latitude on a side in the belief this value represents half the wave length of fast-moving disturbances. Figure (8) illustrates this grid.



d = 625 Km.

Figure (8). Fjortoft's Grid

This is an awkward grid to use on meteorological charts which employ latitude longitude as primary coordinates. In computing zonal wind profiles and 24-hour height changes, height values usually are read from analyzed charts at latitude-longitude intersections. Accordingly, space mean charts should be computed from these values if possible.

The short waves have been defined as the perturbations to be removed to show the long waves. Their identification wi the 24-hour tendencies was shown in Figure (3). The average number of these short waves around the hemisphere is about 7 1/2. This would theoretically require an east-west averaging dimension of 24 degrees of longitude, the half wavelength. This result shows that a variety of grid sizes has theoretical appeal. It was decided to test empirically a variety of sizes and shapes of grids.

A chart comparing a 10° latitude-longitude grid with the Fjortoft grid is shown in Figure (9).

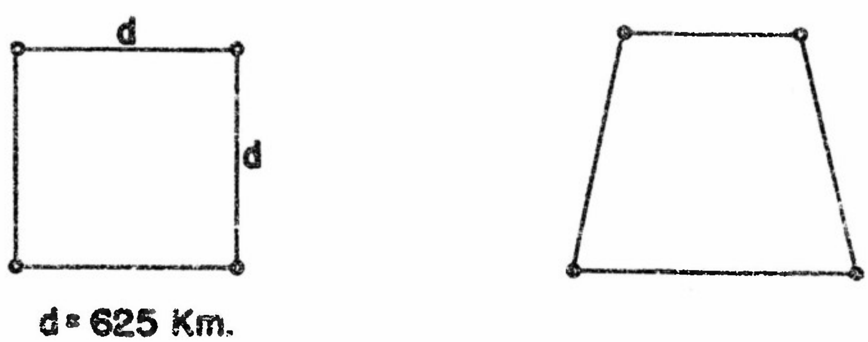


Figure (9). Fjortoft's Grid and 10° Latitude-Longitude "Square".

When no significant differences in mean charts constructed from the grids in Figure (9) were revealed, it was decided to test empirically a variety of sizes and shapes of grids. Figure (10) lists these grids.

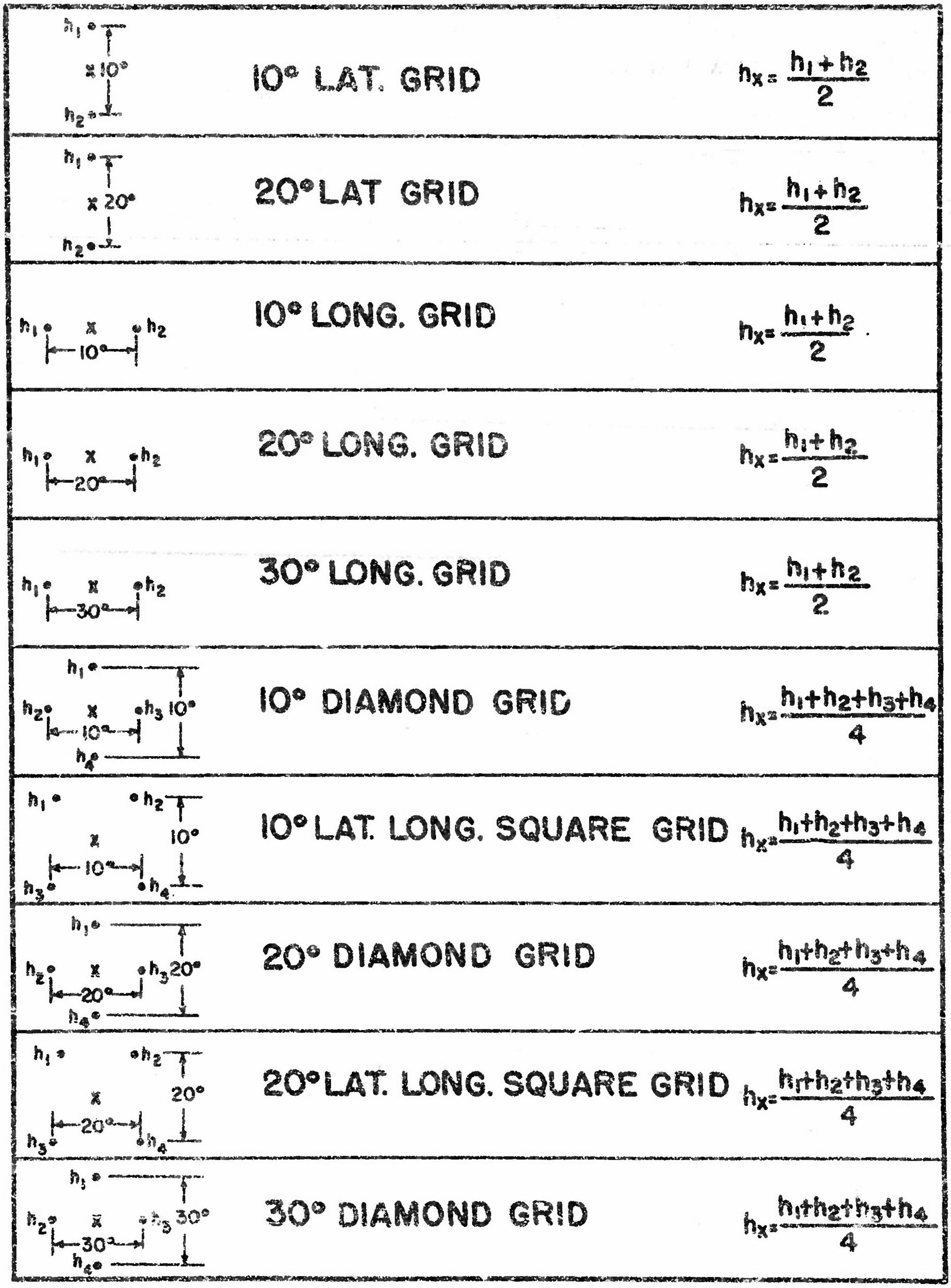


Figure (10). Space Mean Grids

Space mean charts for both the seventh and twenty-seventh of December, 1951 were prepared for each of the grids. On December 7 the middle-latitude flow was marked by open-wave patterns and a circumpolar symmetry. On December 27 the central Pacific lay under a strong block, with open-wave patterns over the remainder of the hemisphere. These conditions constituted a particularly severe test of the space-averaging method, because of the location of short-wave troughs around the block. A method which would remove the cyclonic curvature at the top of the block (165W Longitude) and which would produce a symmetrical pattern about a line N-S through the center of the block was required. In addition, all short-wave features would have to be damped out, so that the main pattern of flow might be evident. Figures (1) and (2) show the patterns for December 7 and December 27.

Several desirable features of the long-wave pattern and the relative success of each grid in representing these features are shown in the following tables.

The 20° diamond is apparently the most effective for space averaging. Analyzed space mean charts for the various grids for 7 and 27 December are included in Figures (1b) through (1k) and (2b) through (2k), while the 5-day time means for these two days are shown in Figures (1 l) and (2 l).

Table I. Space Mean Grid Evaluation for 7 December 1951

Grid \ Feature	No. of Waves	Distortion	Sharpness	Shape of Long Wave Trough in U. S.	Relative Goodness
10° Latitude	Fair	Fair	Good	Good	2
20° Latitude	Good	Good	Good	Good	1
10° Longitude	Poor	Poor	Fair	Poor	6
20° Longitude	Poor	Poor	Poor	Fair	6
30° Longitude	Poor	Poor	Poor	Fair	6
10° Diamond	Poor	Fair	Fair	Fair	5
10° Square	Fair	Fair	Good	Fair	3
20° Diamond	Good	Good	Good	Good	best
20° Square	Good	Good	Good	Good	1
30° Diamond	Fair	Fair	Fair	Fair	4

Table II. Space Mean Grid Evaluation for 27 December 1951

Grid \ Feature	No. of Waves	Distortion	Removal of Short Wave Trough at 165° W	Shape of Block in Pacific	Relative Goodness
10° Latitude	Good	Poor	Good	Poor	5
20° Latitude	Good	Poor	Good	Poor	5
10° Longitude	Fair	Fair	Poor	Poor	5
20° Longitude	Fair	Poor	Fair	Fair	4
30° Longitude	Poor	Poor	Good	Poor	6
10° Diamond	Fair	Fair	Fair	Poor	4
10° Square	Fair	Fair	Fair	Fair	2
20° Diamond	Good	Good	Good	Good	best
20° Square	Good	Fair	Good	Poor	3
30° Diamond	Poor	Poor	Good	Poor	6

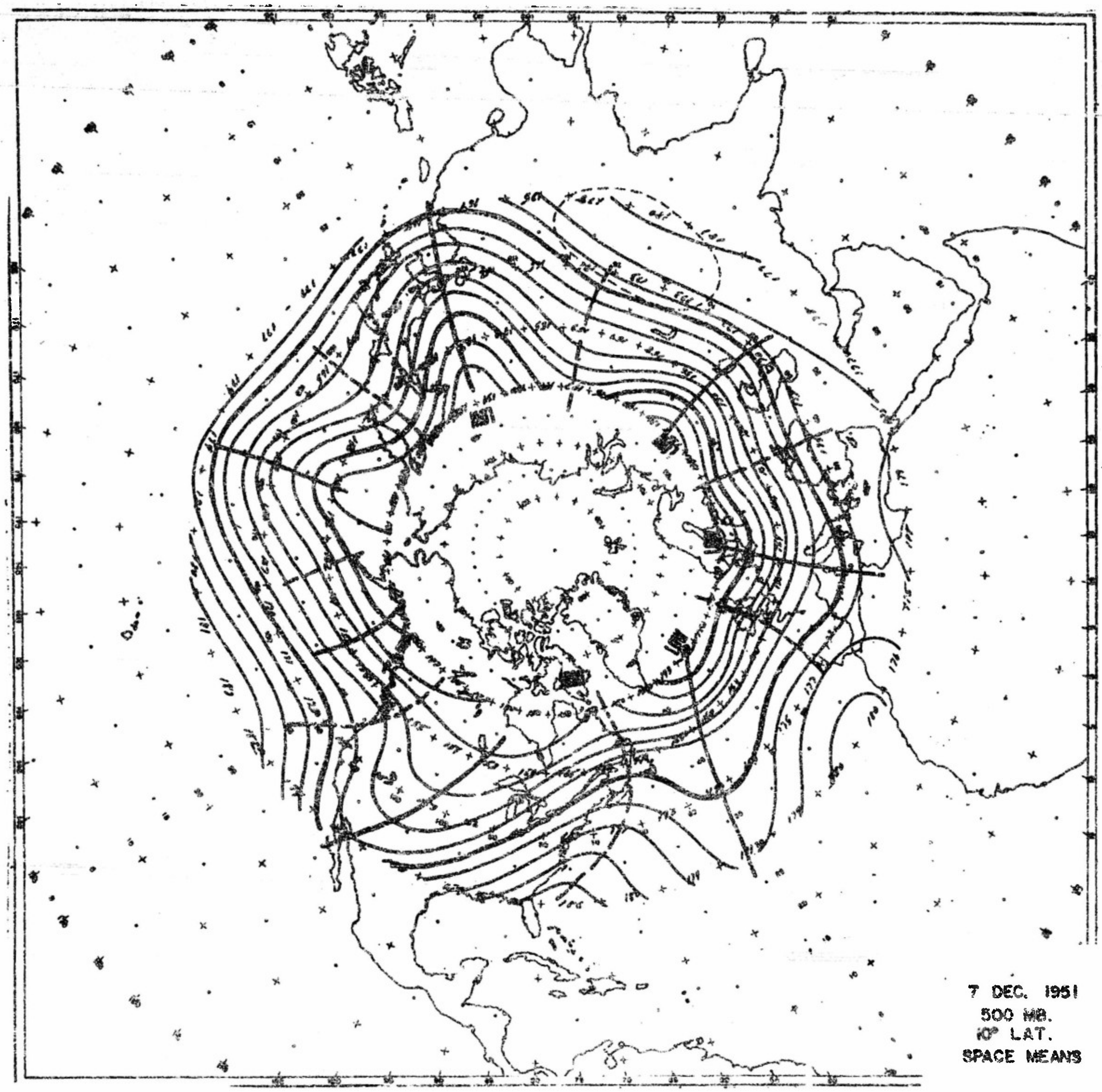


Figure (1b). Space Mean - 10° Latitude - 7 December 1951

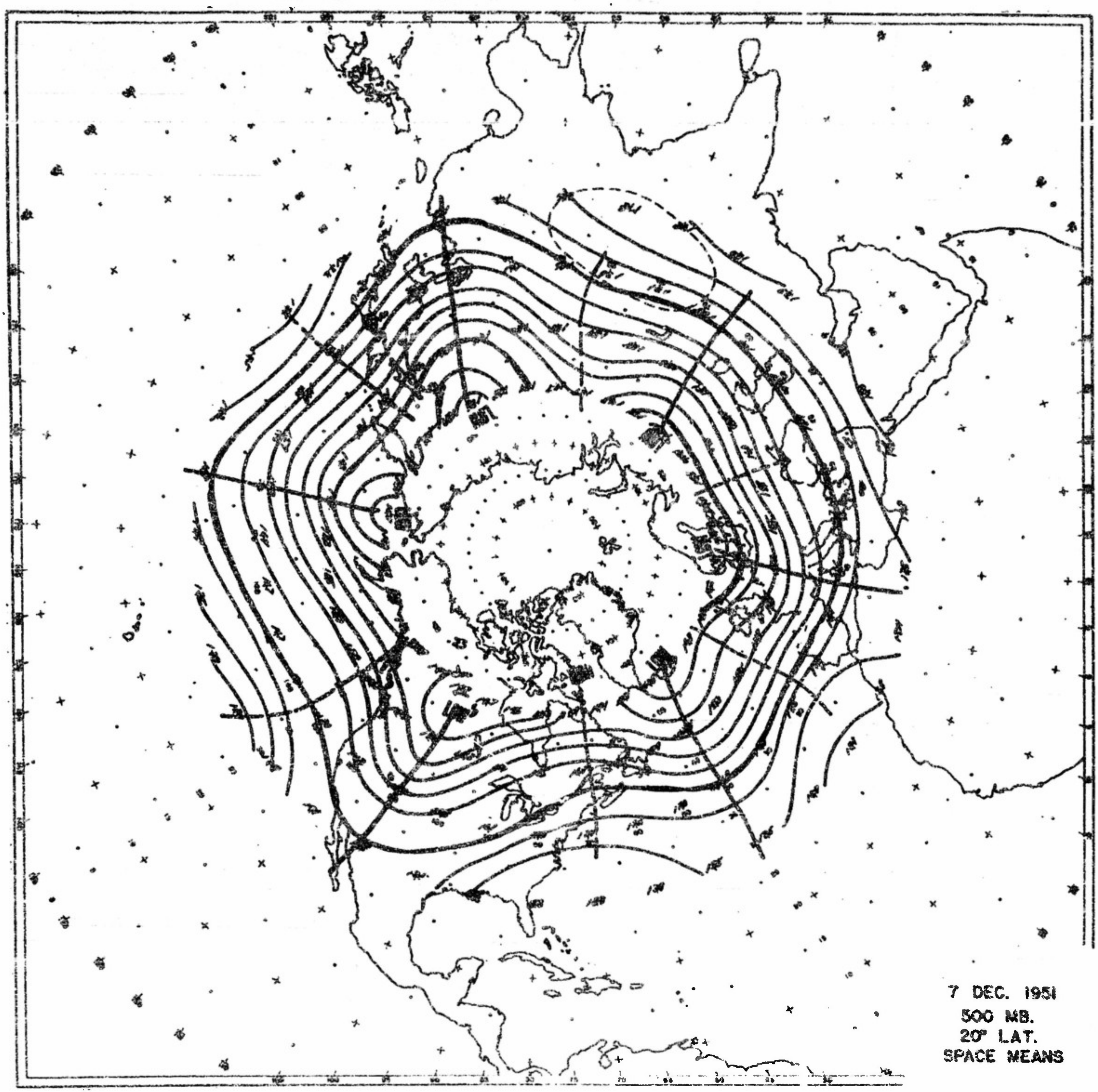


Figure (1c). Space Mean - 20° Latitude - 7 December 1951

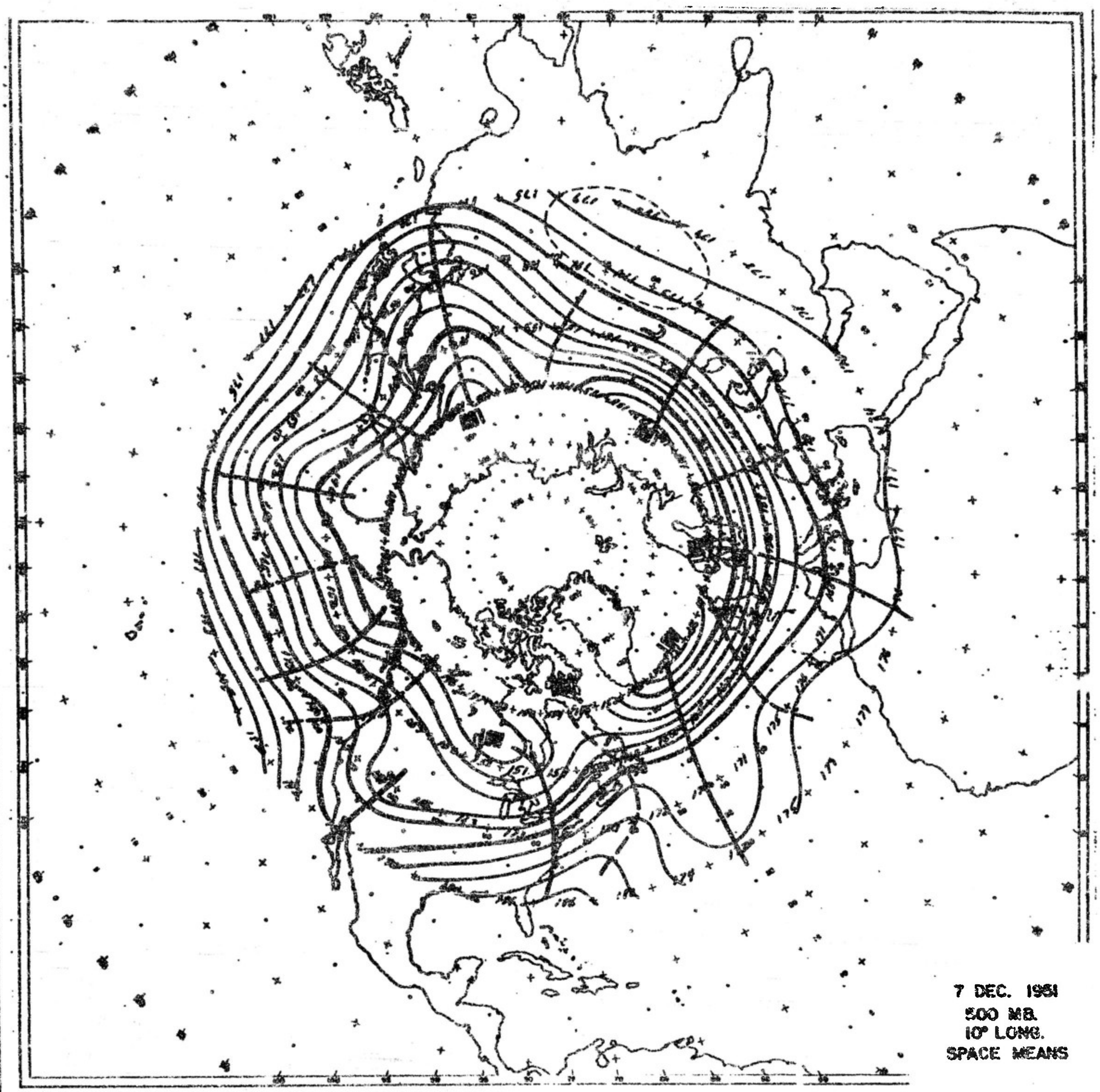


Figure (1d). Space Mean - 10° Longitude - 7 December 1951

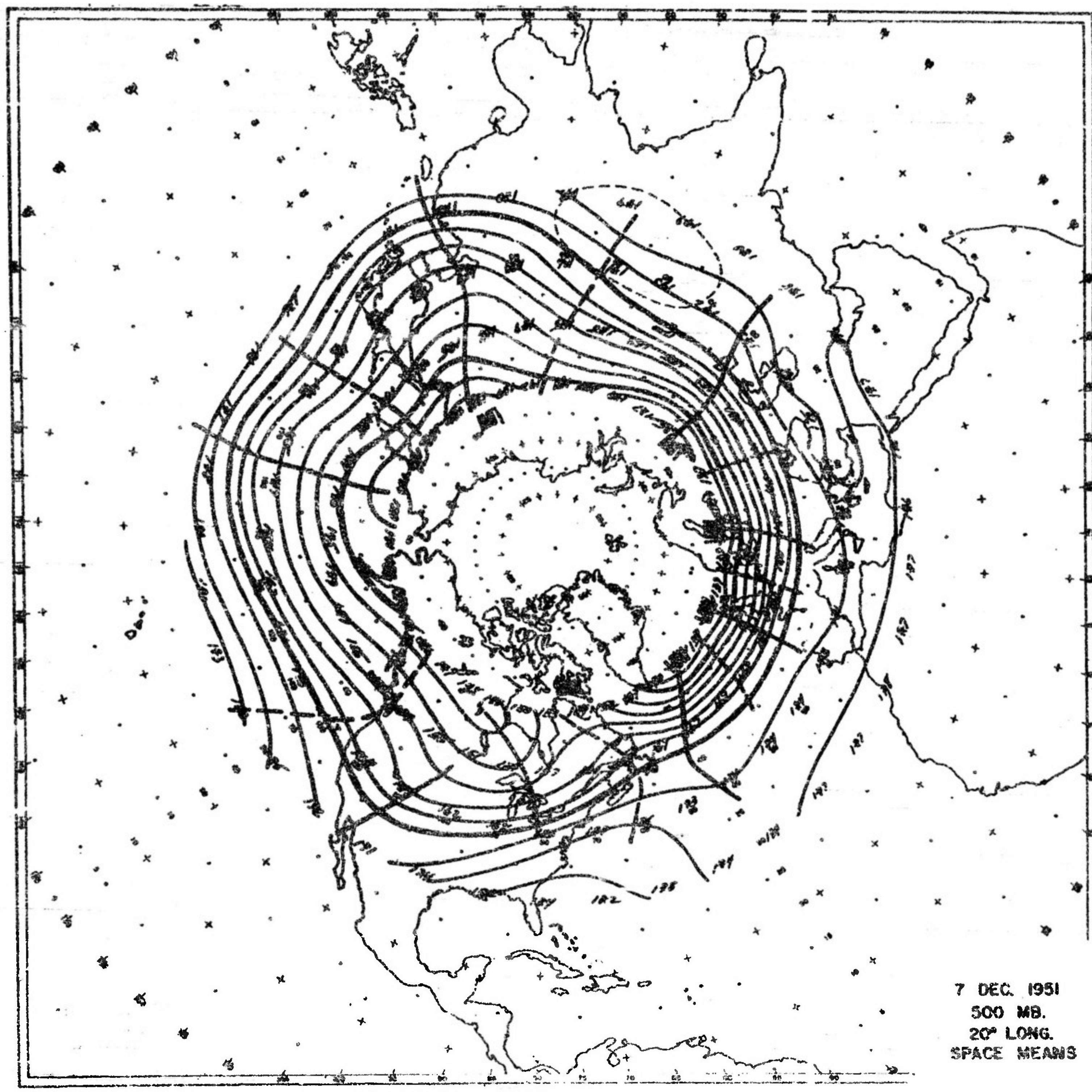


Figure (1e). Space Mean - 20° Longitude - 7 December 1951

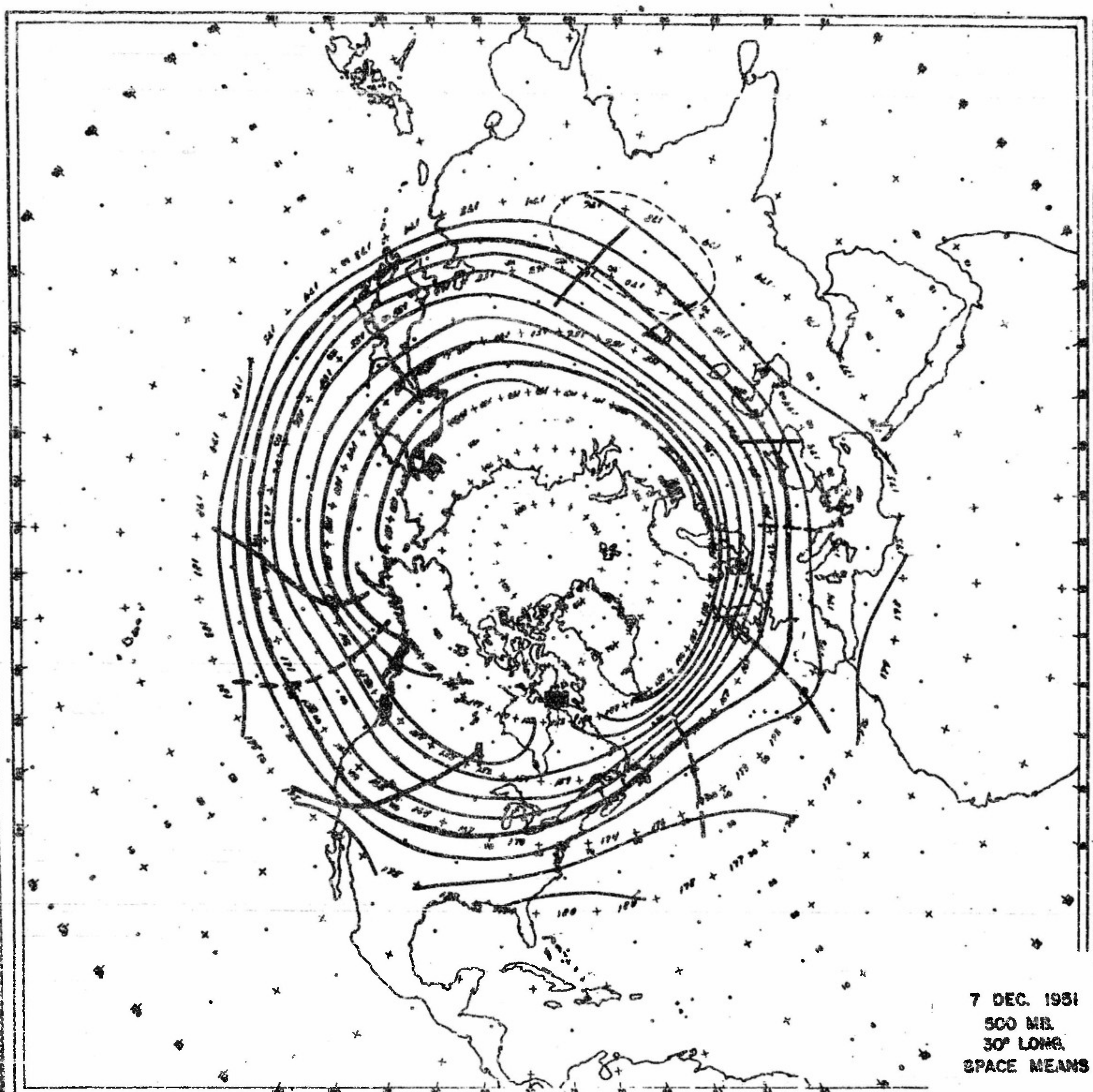


Figure (1f). Space Mean - 30° Longitude - 7 December 1951

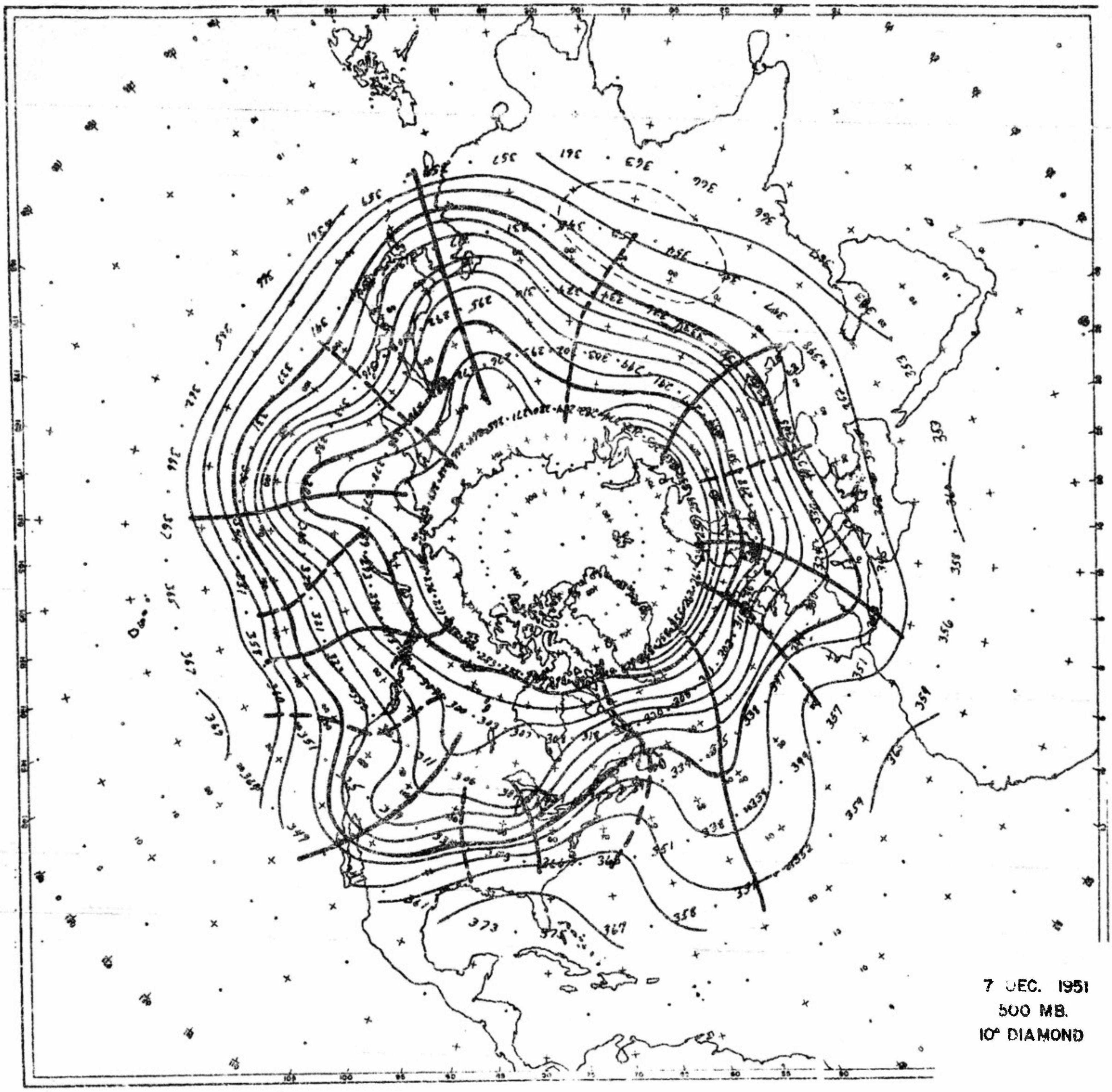


Figure (1g). Space Mean - 10° Diamond - 7 December 1951

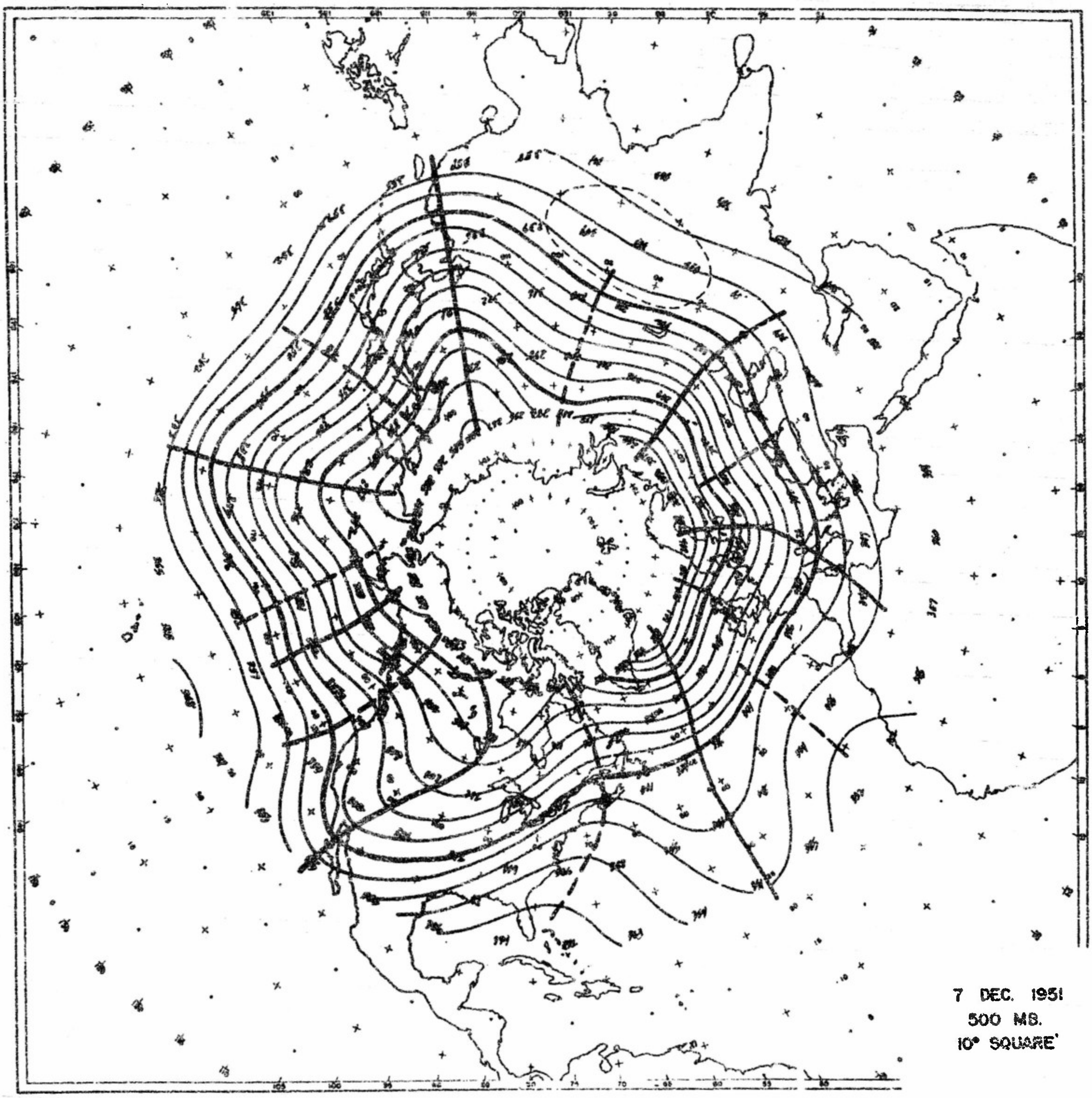


Figure (1h). Space Mean - 10° Latitude-Longitude Square - 7 December 1951

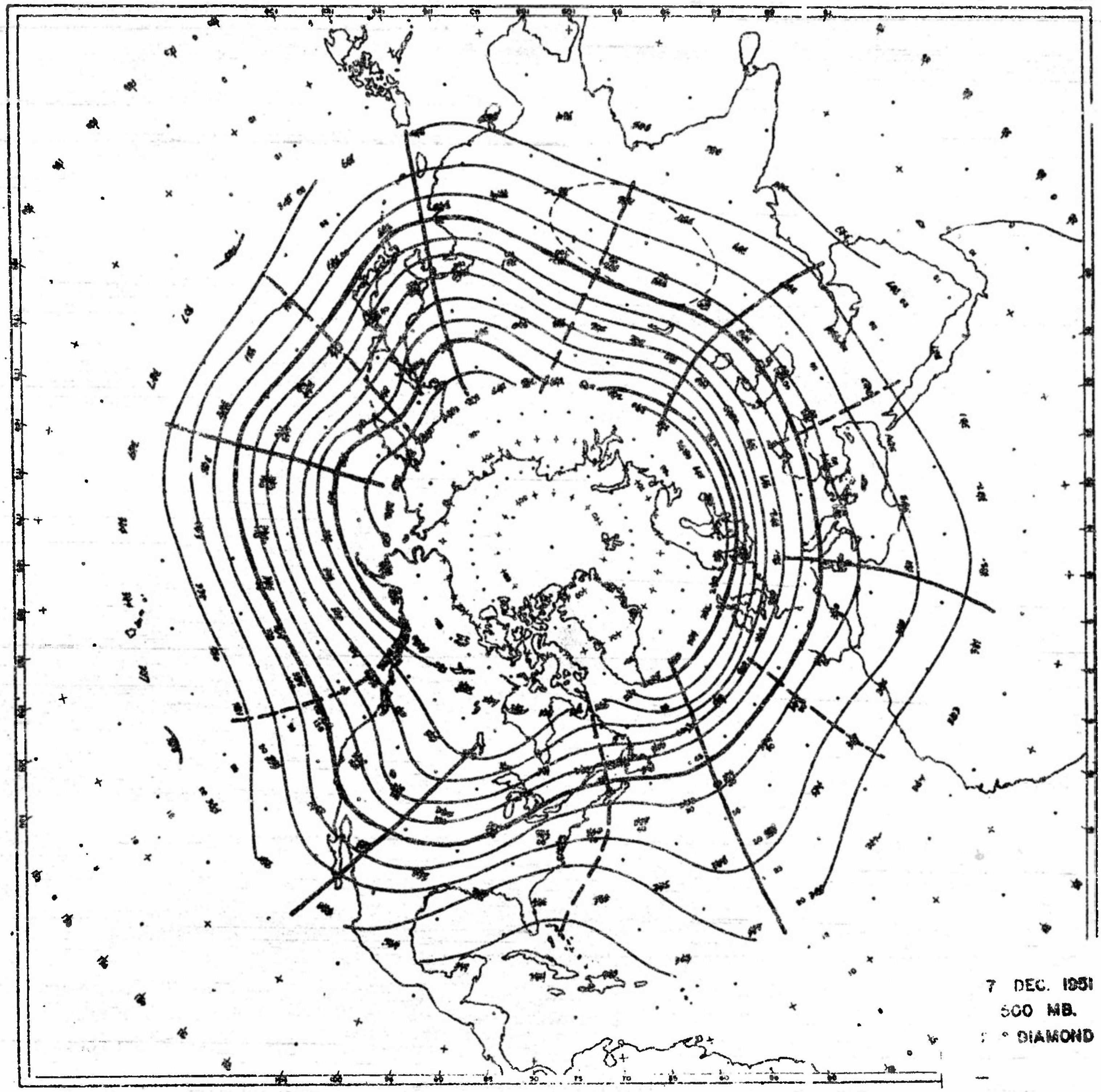


Figure (1i). Space Mean - 20° Diamond - 7 December 1951

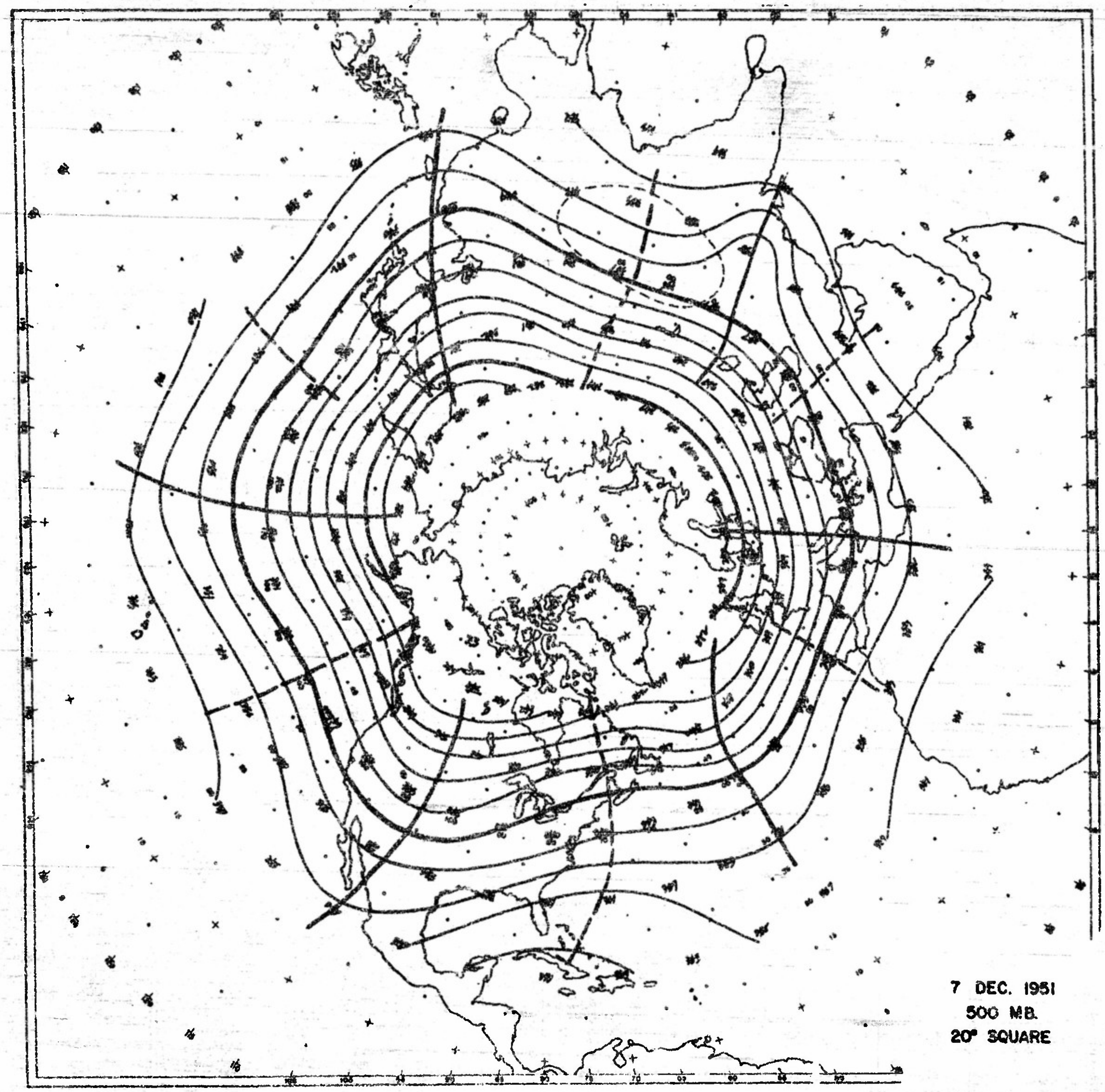


Figure (1j). Space Mean - 20° Latitude-Longitude Square - 7 December 1951

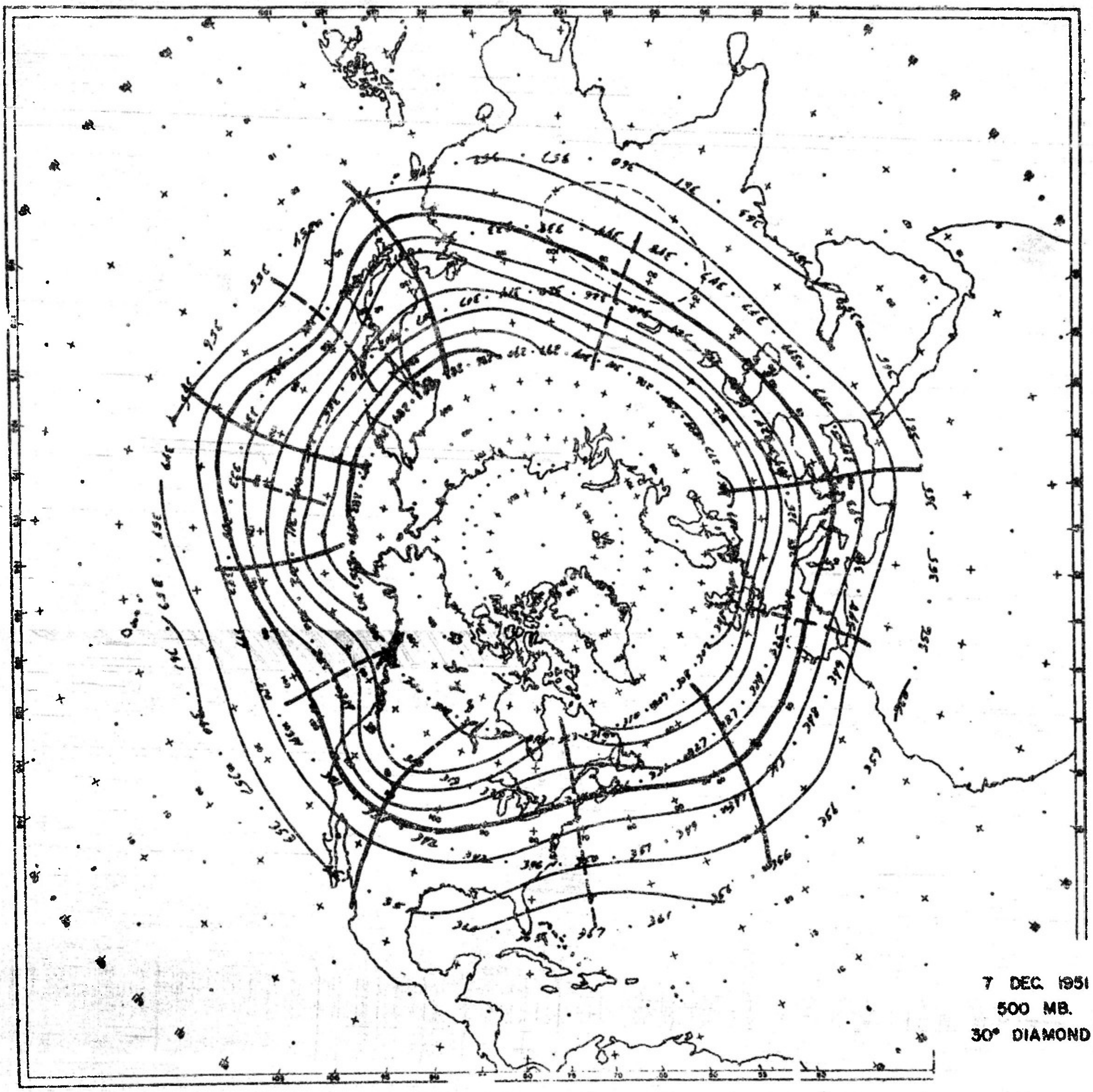


Figure (1k). Space Mean - 30° Diamond - 7 December 1951

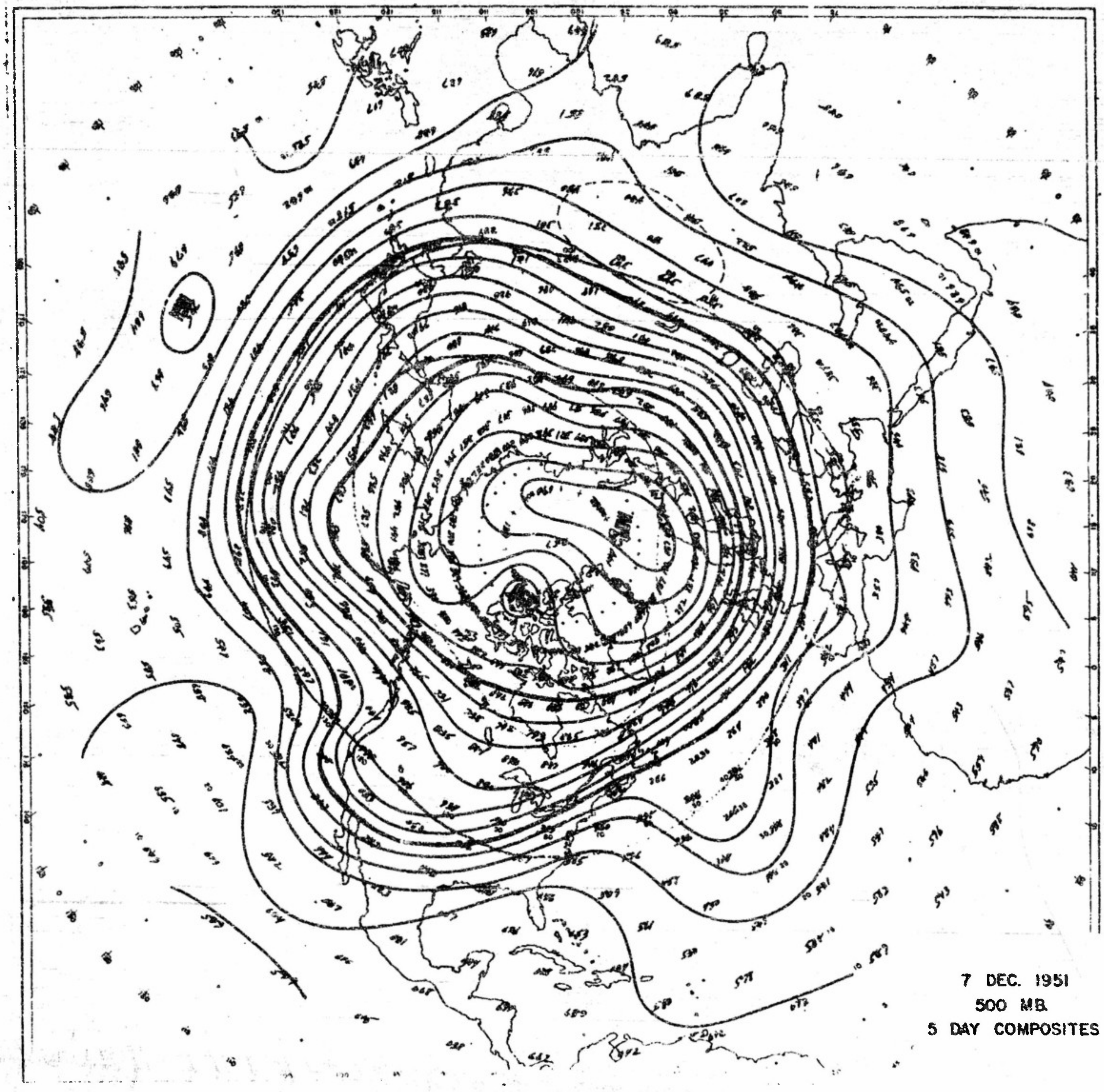


Figure (11). 5-Day Mean Chart
5, 6, 7, 8, 9 December 1951

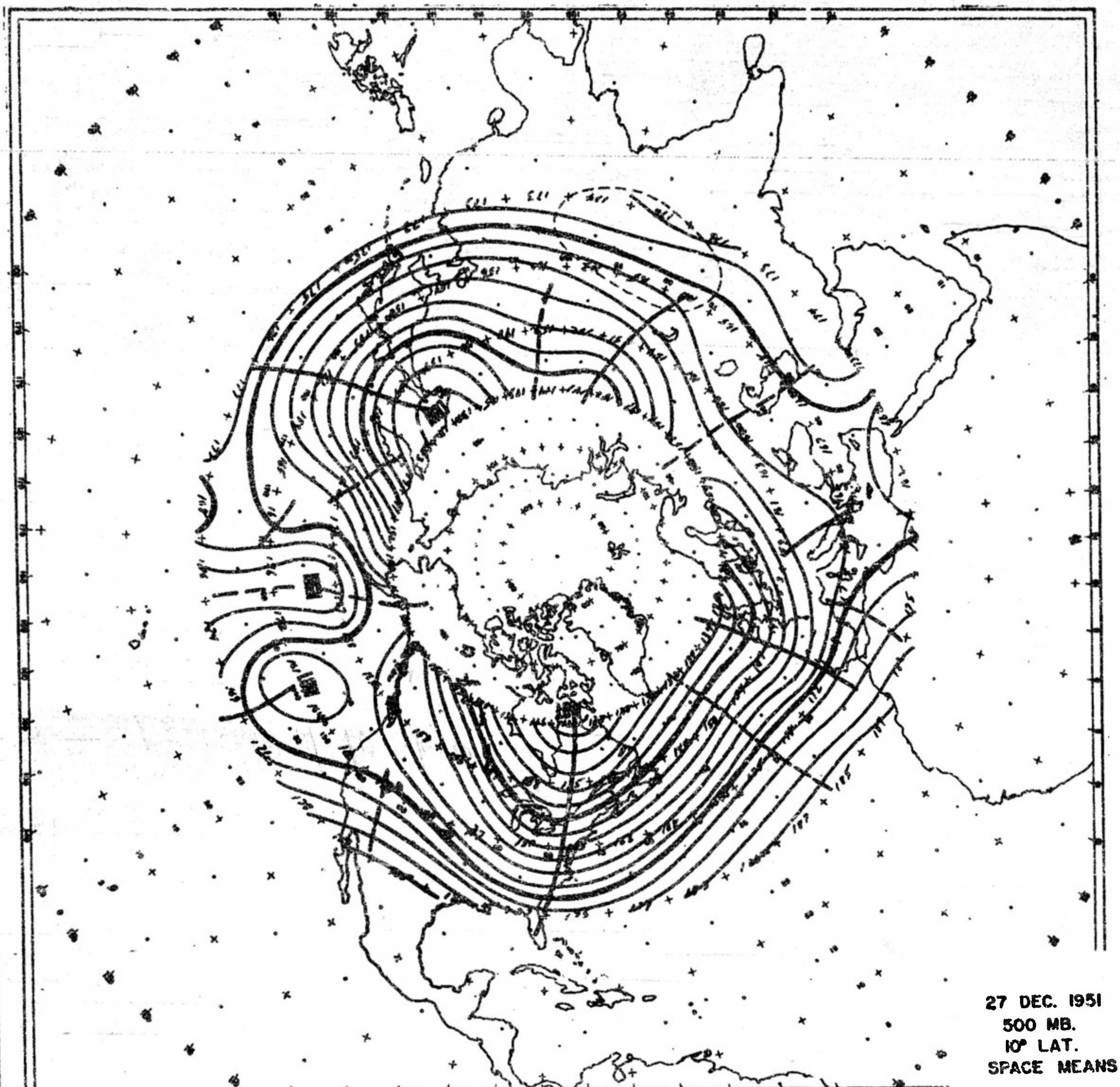


Figure (2b). Space Mean - 10° Latitude - 27 December 1951

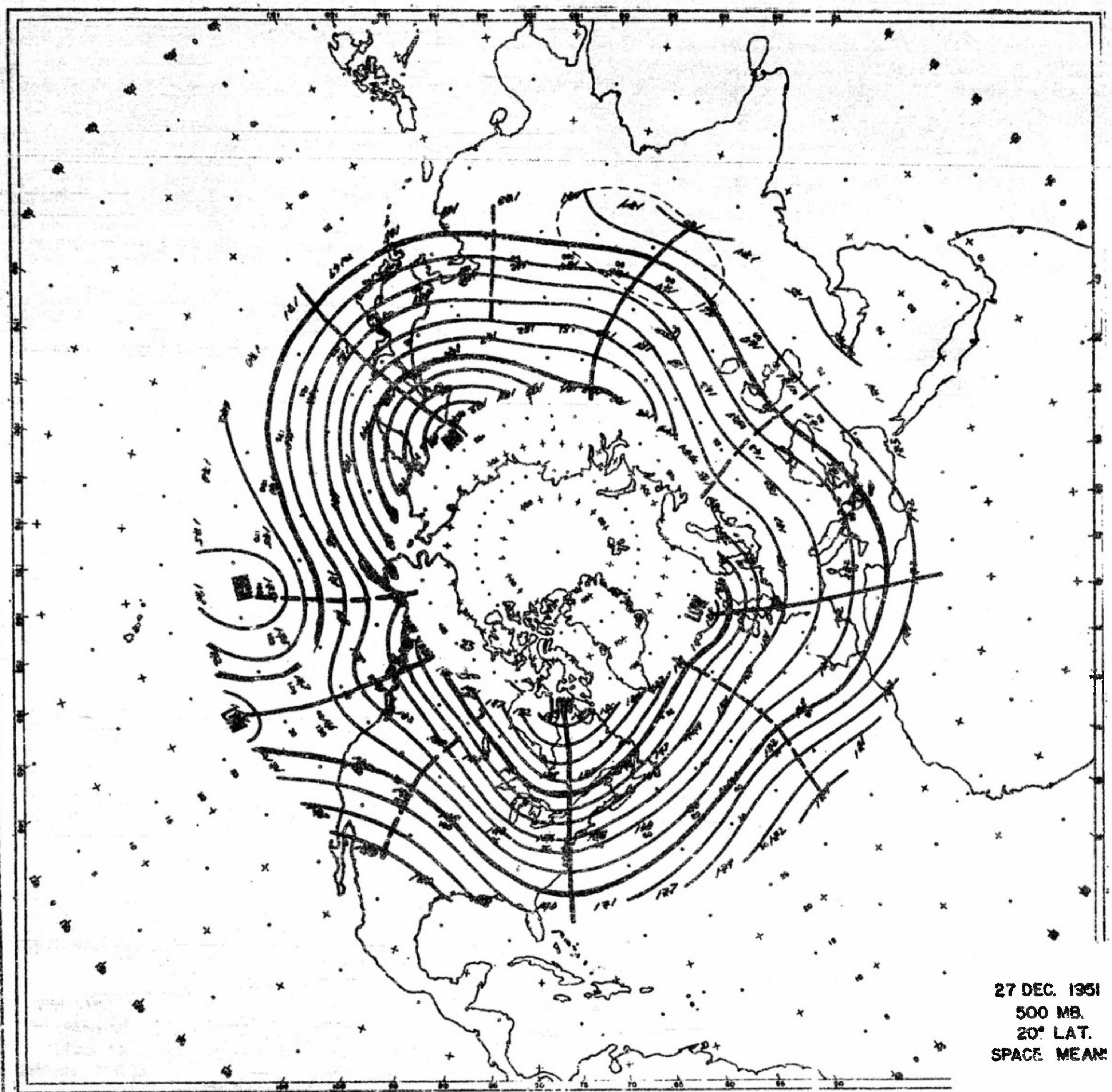


Figure (2c). Space Mean - 20° Latitude - 27 December 1951

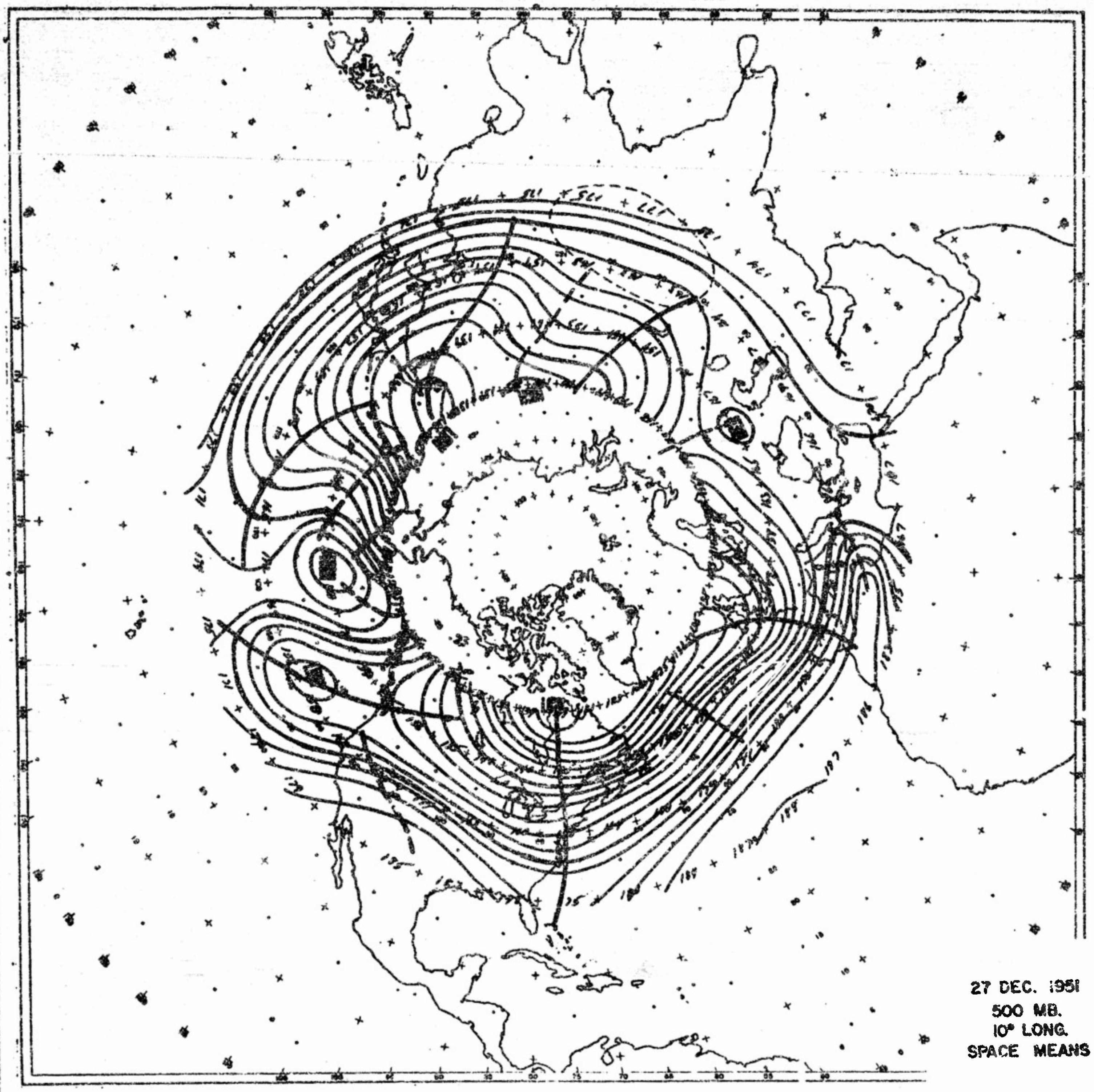


Figure (2d). Space Mean - 10° Longitude - 27 December 1951

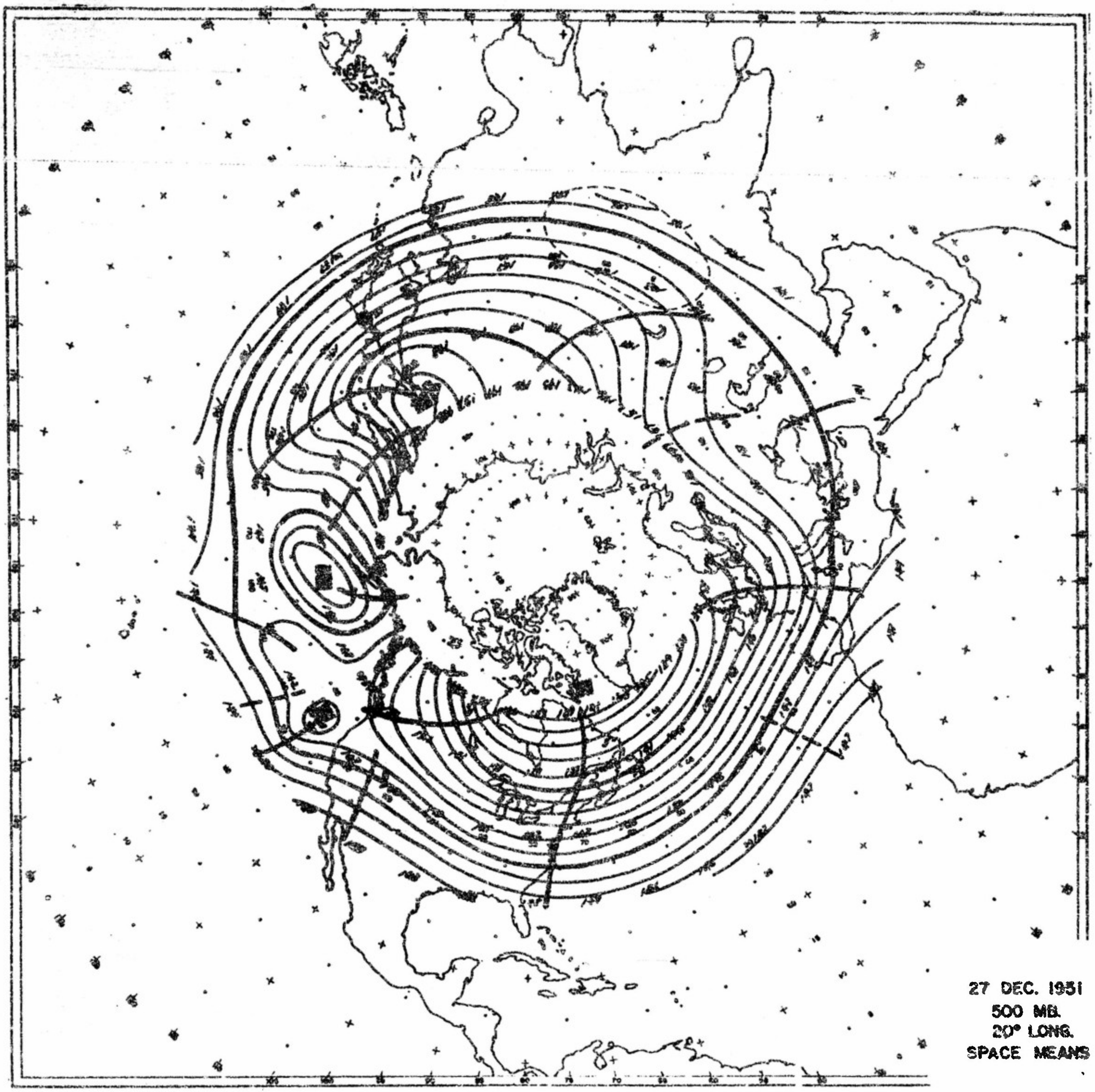


Figure (2e). Space Mean - 20° Longitude - 27 December 1951

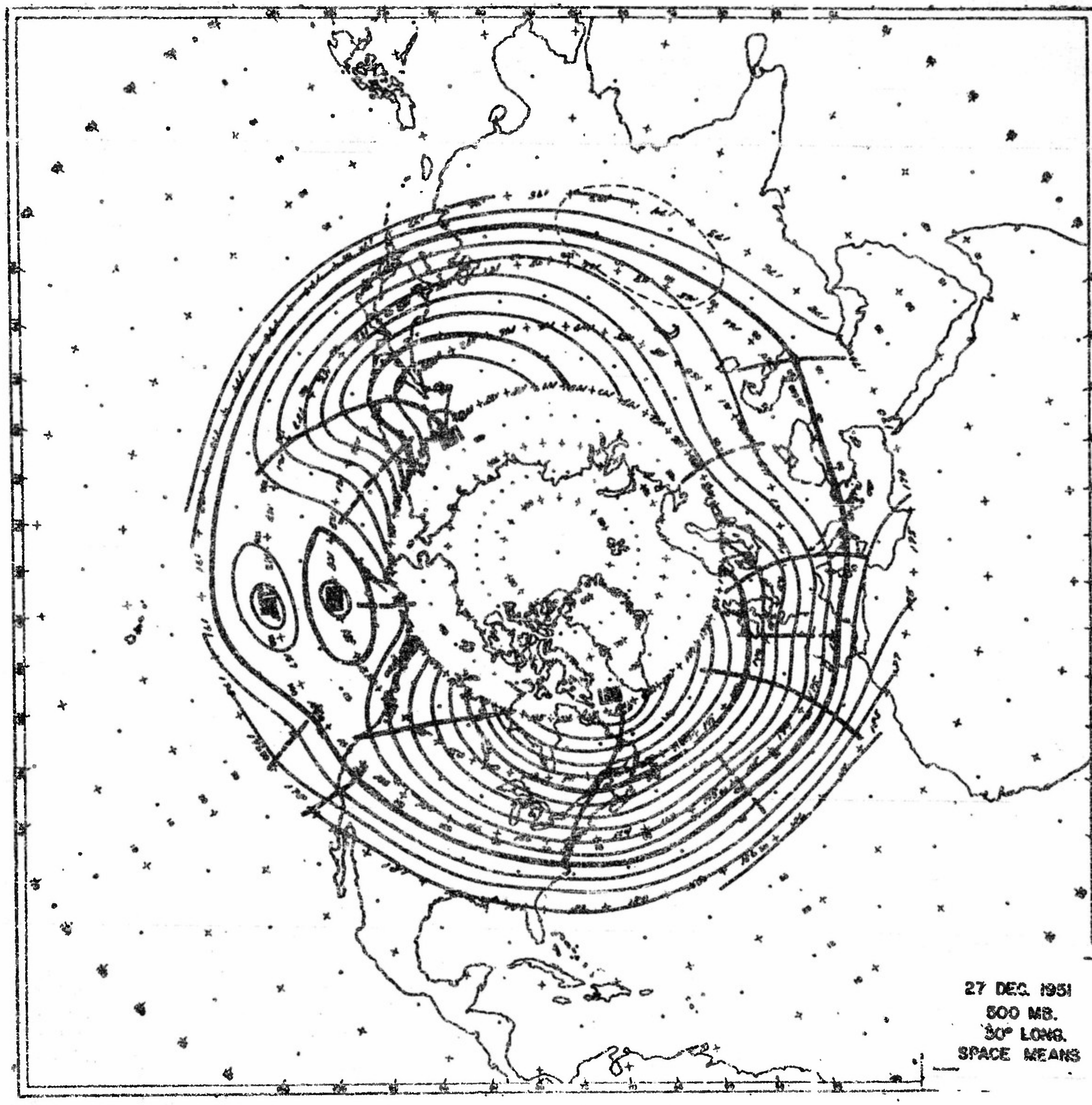


Figure (2f). Space Mean - 30° Longitude - 27 December 1951

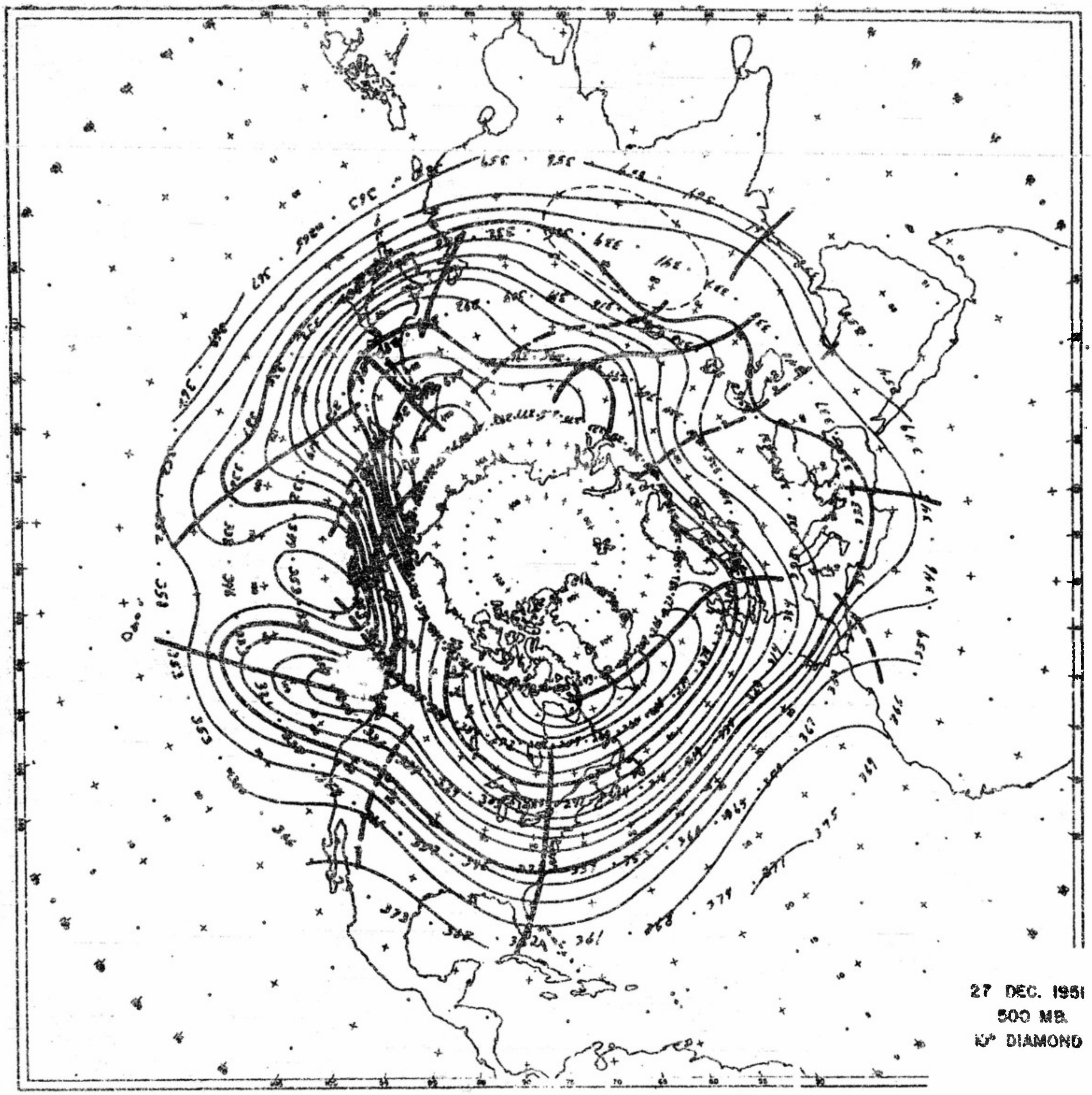


Figure (2g). Space Mean - 10° Diamond - 27 December 1951

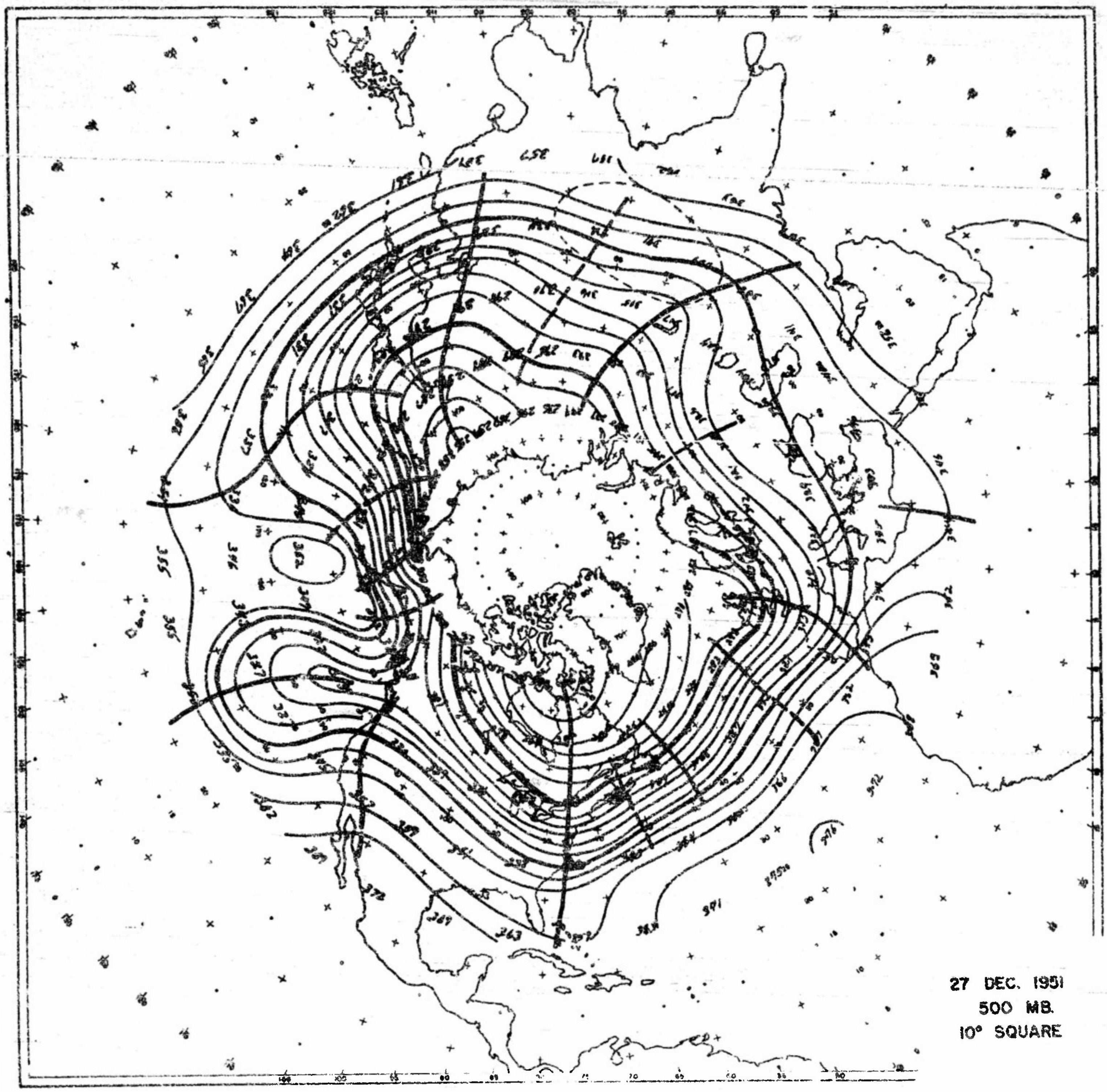


Figure (2h). Space Mean - 10° Latitude-Longitude Square - 27 December 1951

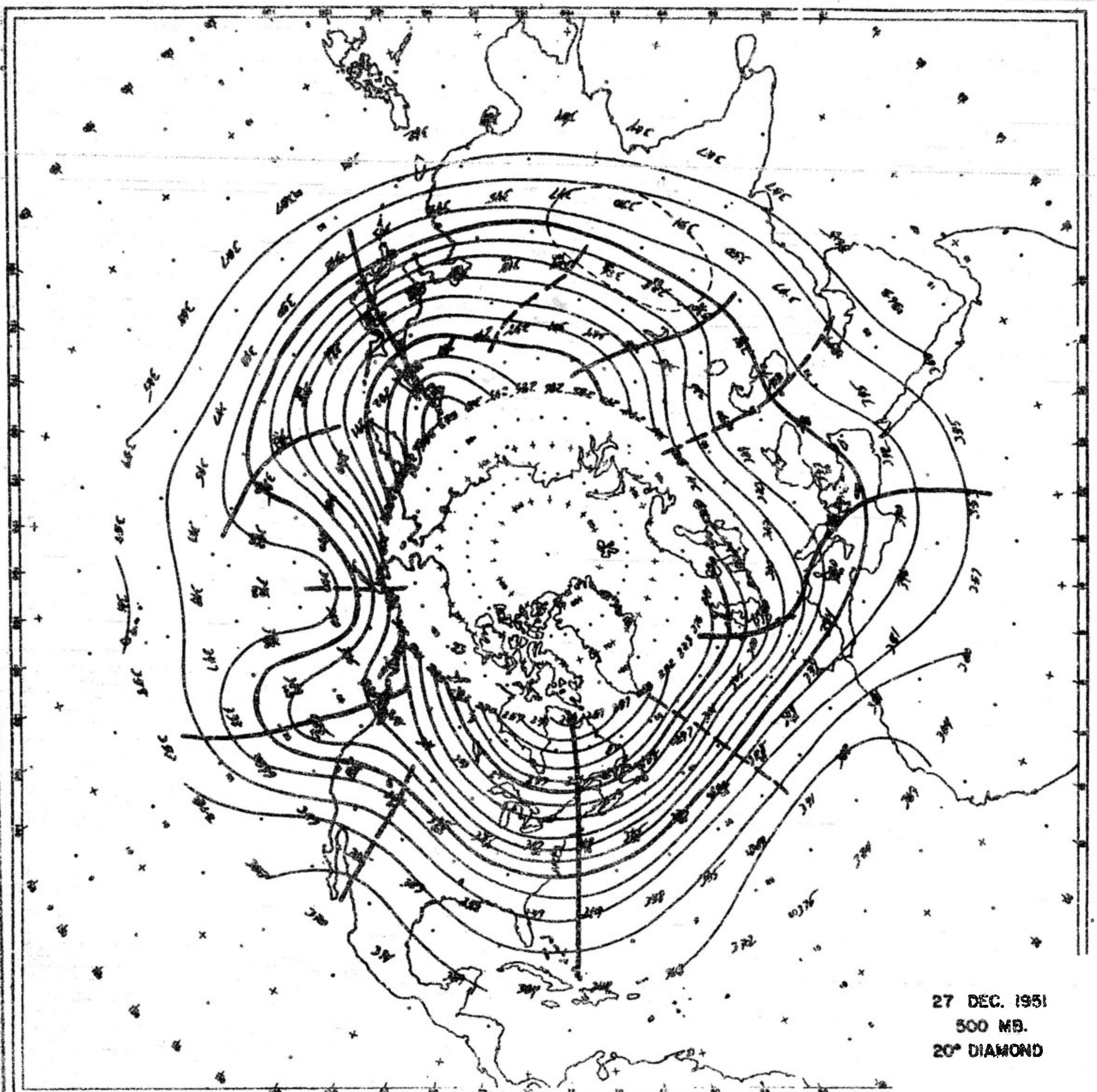


Figure (2i). Space Mean - 20° Diamond - 27 December 1951

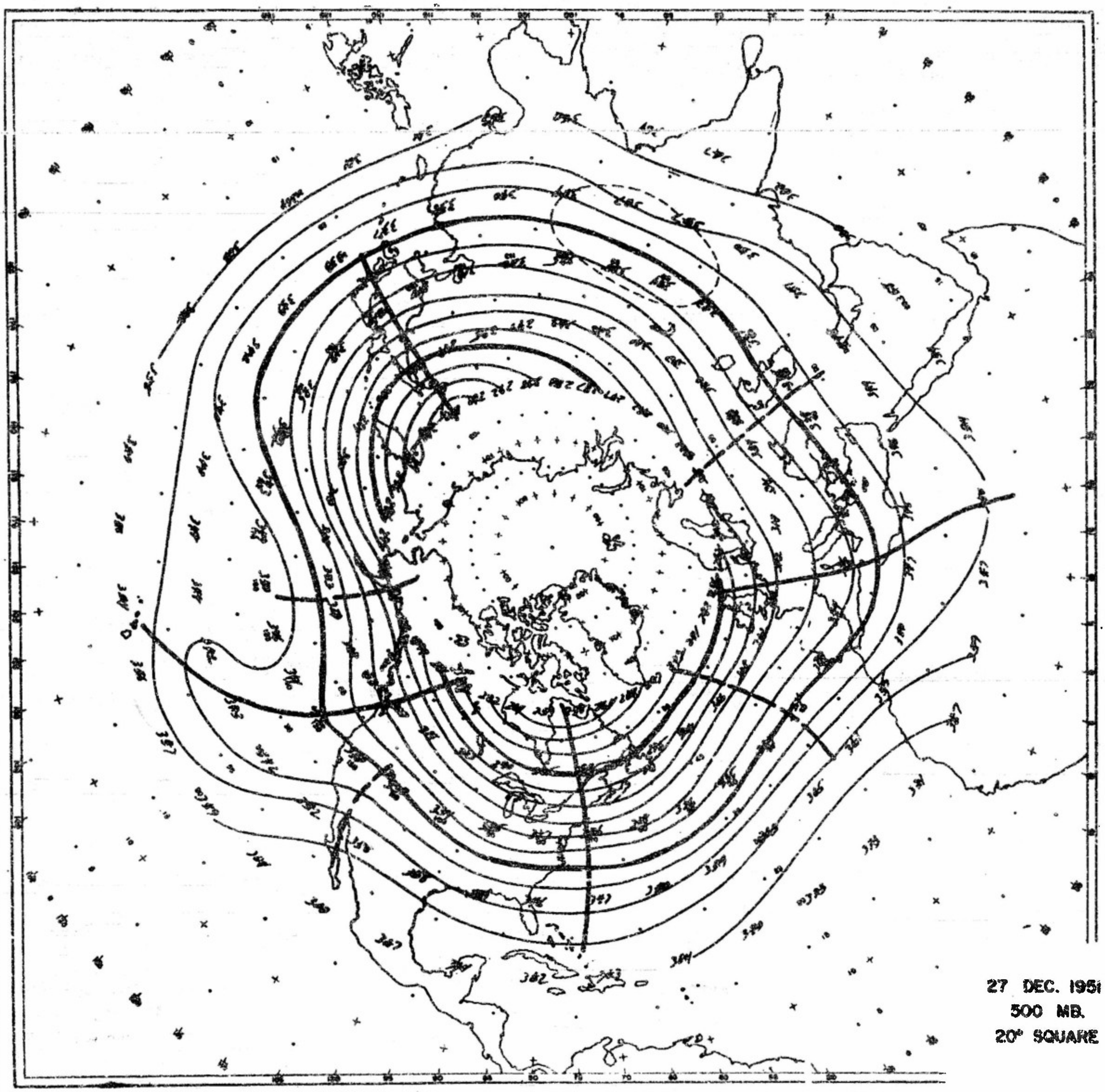


Figure (2j). Space Mean - 20° Latitude-Longitude Square - 27 December 1951

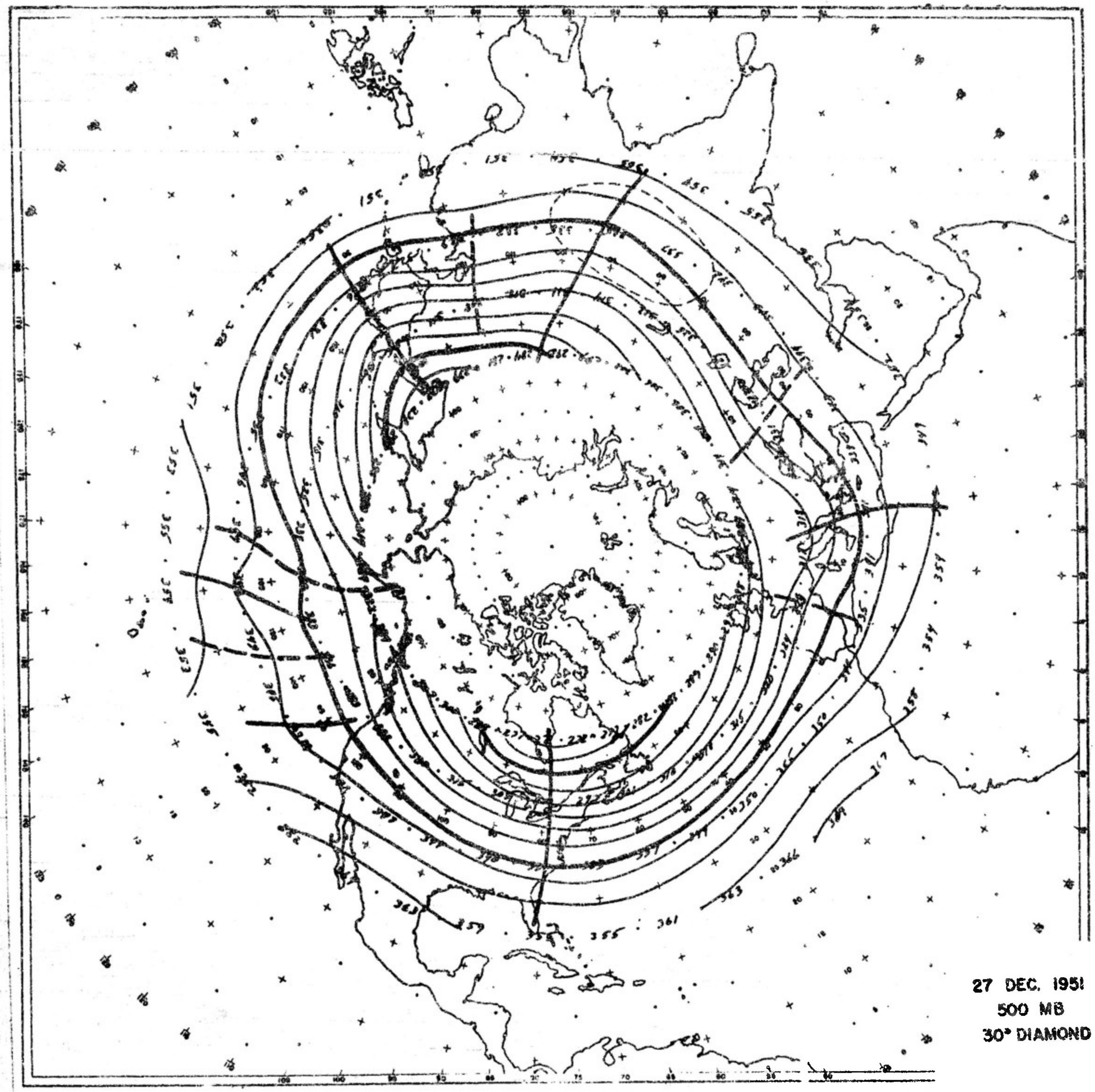


Figure (2k). Space Mean - 30° Diamond - 27 December 1951

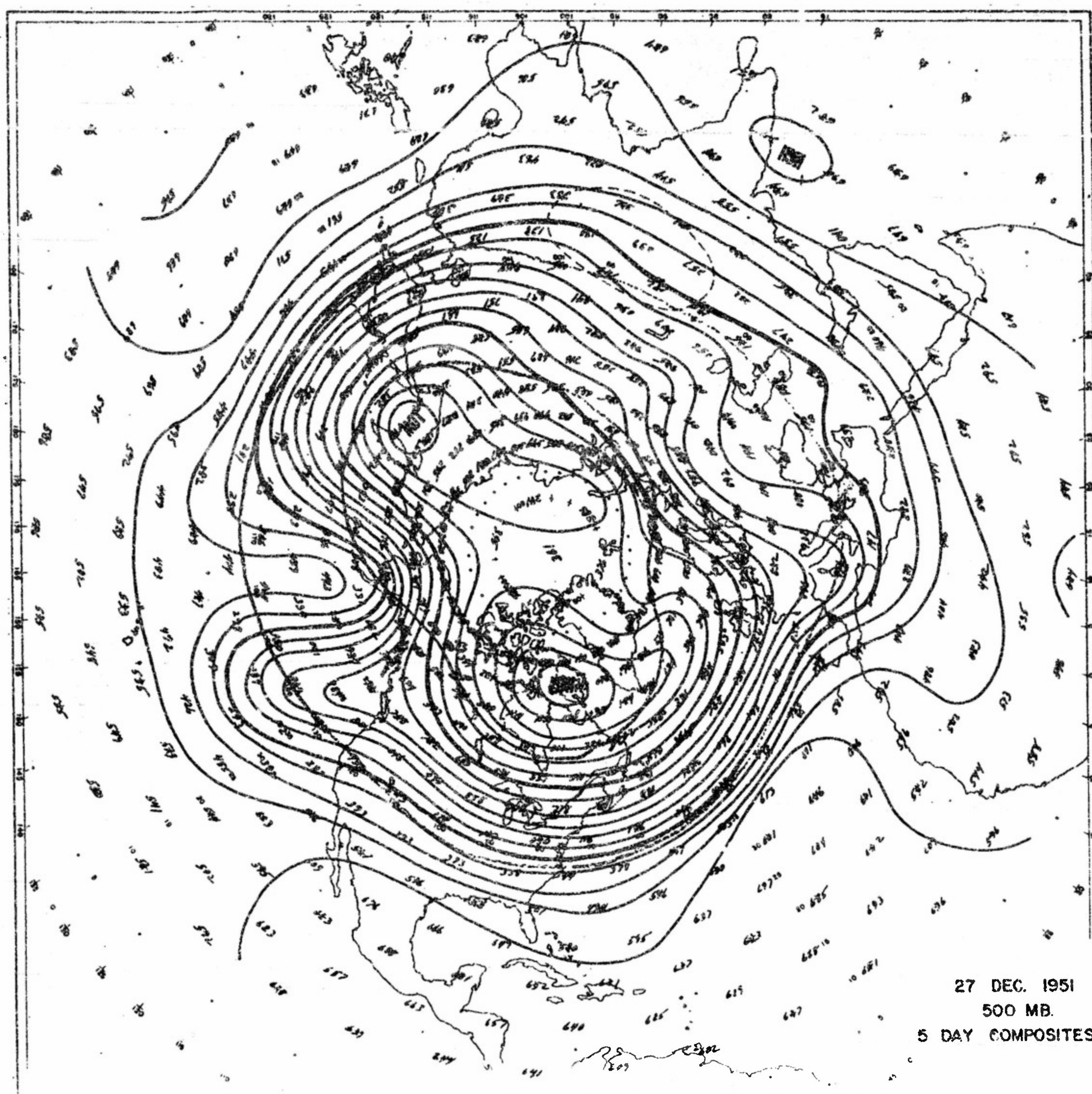


Figure (21). 5-Day Mean Chart
25, 26, 27, 28, 29 December 1951

5. Long-Wave Tendencies

Since use of the 20° diamond seems to disclose patterns of long waves quite successfully, it is logical to take the 24-hour differences between charts to represent the tendency field created by these waves. The total 24-hour difference in heights may then be considered as the sum of long-wave and short-wave tendencies. Values for the long-wave tendencies are surprisingly large. Research is in progress to determine the meteorological significance of various combinations of long-and short-wave tendencies. A series of analyzed charts of the long-wave tendencies is included in the Appendix. The number of tendency centers and their varying size attest the applicability of this portrayal.

A summary of differences in meaning and behavior between long- and short-wave tendencies is in order. In a previous study (3) the authors have shown that 24-hour height changes are always progressive in motion and rather conservative in time. Two common patterns and their indicated meanings for short-wave tendencies are shown in Figure (11).

In contrast, available material indicates that while most long-wave tendencies move eastward, some are either stationary or definitely retrogressive. Due probably to their lesser magnitude, the temporal conservativeness of these tendencies is also not as pronounced as that of the total tendency. The meaning of a few of these patterns is clear in Figure (12).

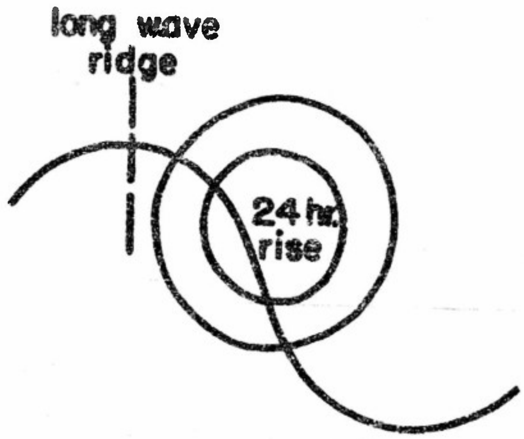


Figure (12a). Long Wave and Long-Wave 24-hr Tendency
Long-Wave Ridge Has Progressed

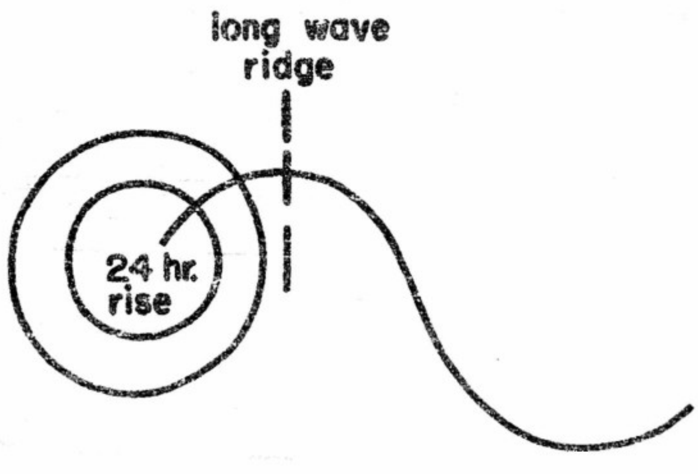


Figure (12b). Long Wave and Long-Wave 24-hr Tendency
Long-Wave Ridge Has Retrograded

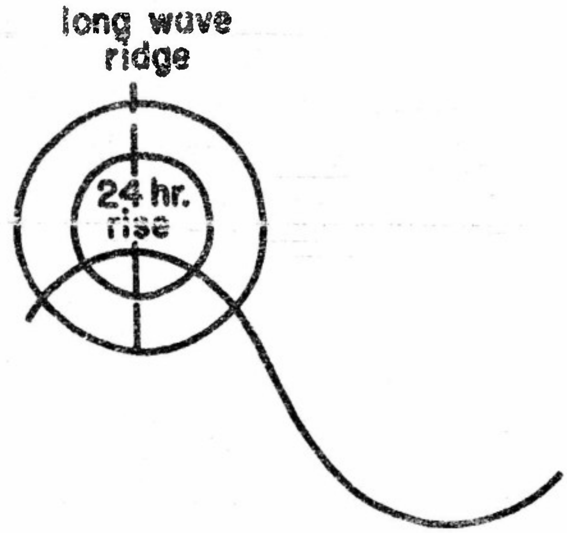


Figure (12c). Long Wave and Long-Wave 24-hr Tendency
Long-Wave Ridge Has Intensified

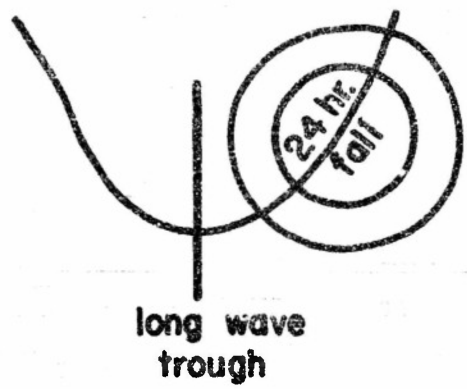


Figure (12d). Long Wave and Long-Wave 24-hr. Tendency
Long-Wave Trough Has Progressed

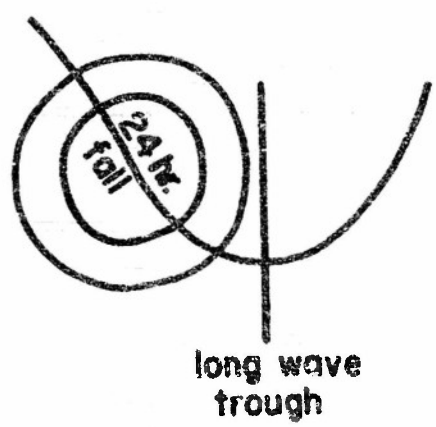


Figure (12e). Long Wave and Long-Wave 24-hr Tendency
Long-Wave Trough Has Retrograded

Figure (12f). Long Wave and Long-Wave 24-hr Tendency
Long-Wave Trough Has Deepened

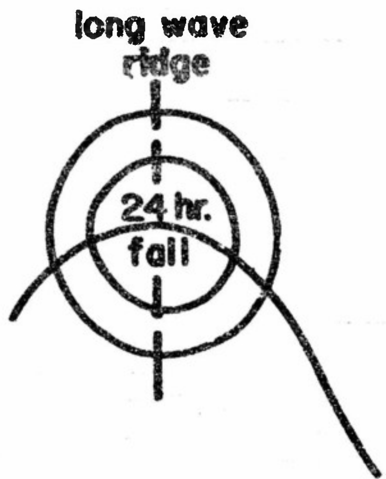


Figure (12g). Long Wave and Long-Wave 24-hr Tendency
Long-Wave Ridge Has Weakened

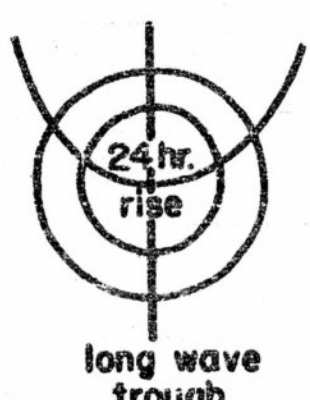


Figure (12h). Long Wave and Long-Wave 24-hr Tendency
Long-Wave Trough Has Weakened

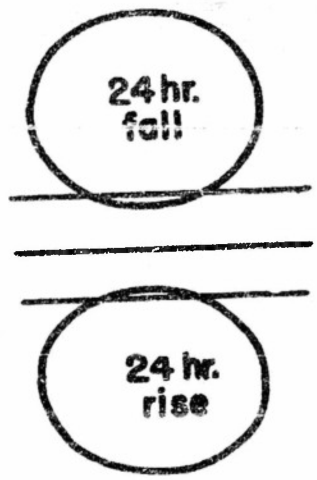


Figure (12i). Long Wave and Long-Wave 24-hr Tendency
Westerly Flow Has Accelerated

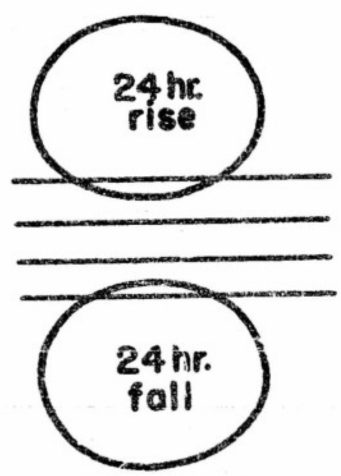


Figure (12j). Long Wave and Long-Wave 24-hr Tendency
Westerly Flow Has Decelerated

6. Continuity

Previous analyses of wave motion at 500 mb have made use of the continuity chart for graphical portrayal. Tested plotting procedure has shown that height profiles from a single latitude are preferable to the averaged values of several latitudes. When based on 20° diamond space-mean charts these continuity graphs are particularly desirable for showing long-wave behavior in a new perspective. The time-scale of long-wave development, moreover, is made easier to evaluate.

A series of continuity charts is presented in the Appendix.

7. Conclusions

1. Wave-like structure of the 500-mb flow confirms the practicality of the long-wave hypothesis.

2. The intimate relation of these structures to surface events makes their quantitative determination essential.

3. The 20° diamond space average is the best means of making these patterns evident.

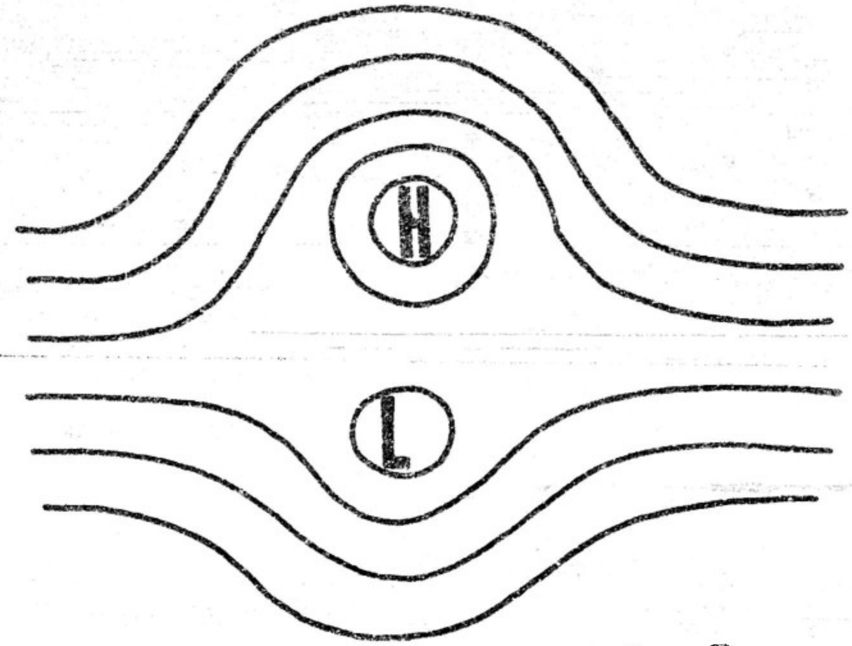
IV. BLOCKING ANALYSIS

Since blocking, an especially persistent phenomenon productive of large-scale anomalies, is the only common pattern of the upper flow which does not fit immediately into a theory of long waves, its treatment here is imperative.

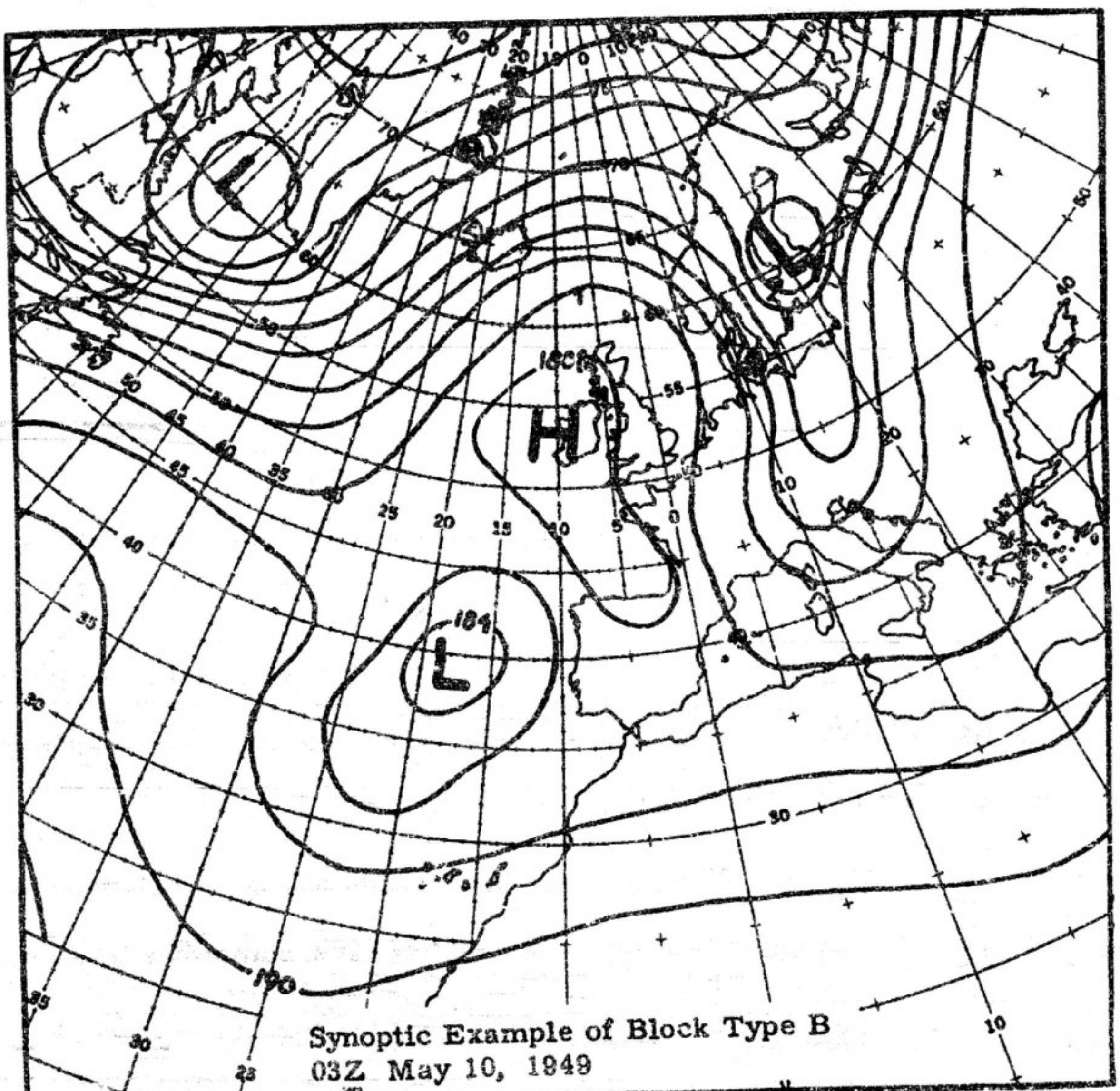
1. Historically

From the turn of the century a number of authors have dealt with this subject, but, unfortunately, each has emphasized only one aspect of the circulatory pattern, a bias reflected in their conflicting conclusions. Rex (6) defines the pattern as a split in the major westerly stream, as illustrated in Figure (13). He insists that the pattern remains identifiable for at least 10 days and is concerned more with its effect on climate than with forecasting its perturbations. On the other hand, Elliott (7) defines a block as a closed anticyclone (at 500 mb) located north of a certain minimal latitude. Less restrictive than that of Rex, his definition extends to patterns, like those shown in Figure (14), which Rex would not recognize as blocks. He assigns the pattern a duration of at least three days and discusses its relation to large-scale transfer processes; he notes a considerable shift of the defining highs about the mean position.

Namias (8) defines blocking as an intensely "plus" departure-from-normal at higher latitudes, a point of view somewhat less objective

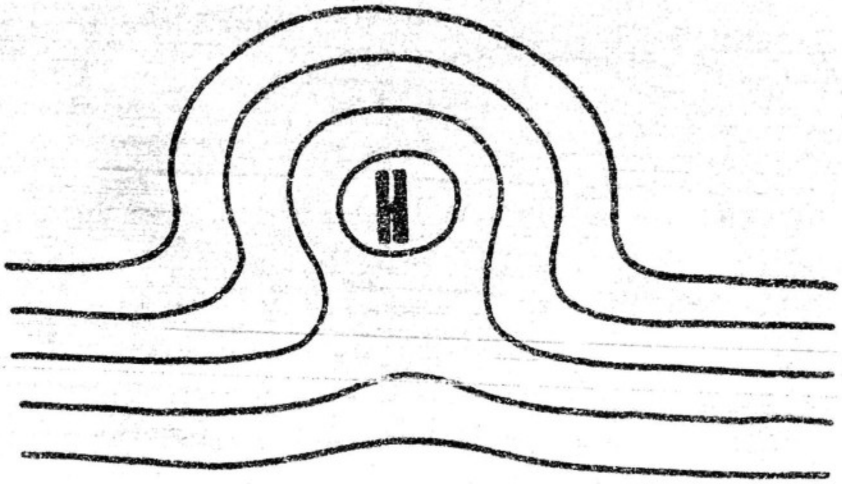


Schematic Diagram of Block Type B

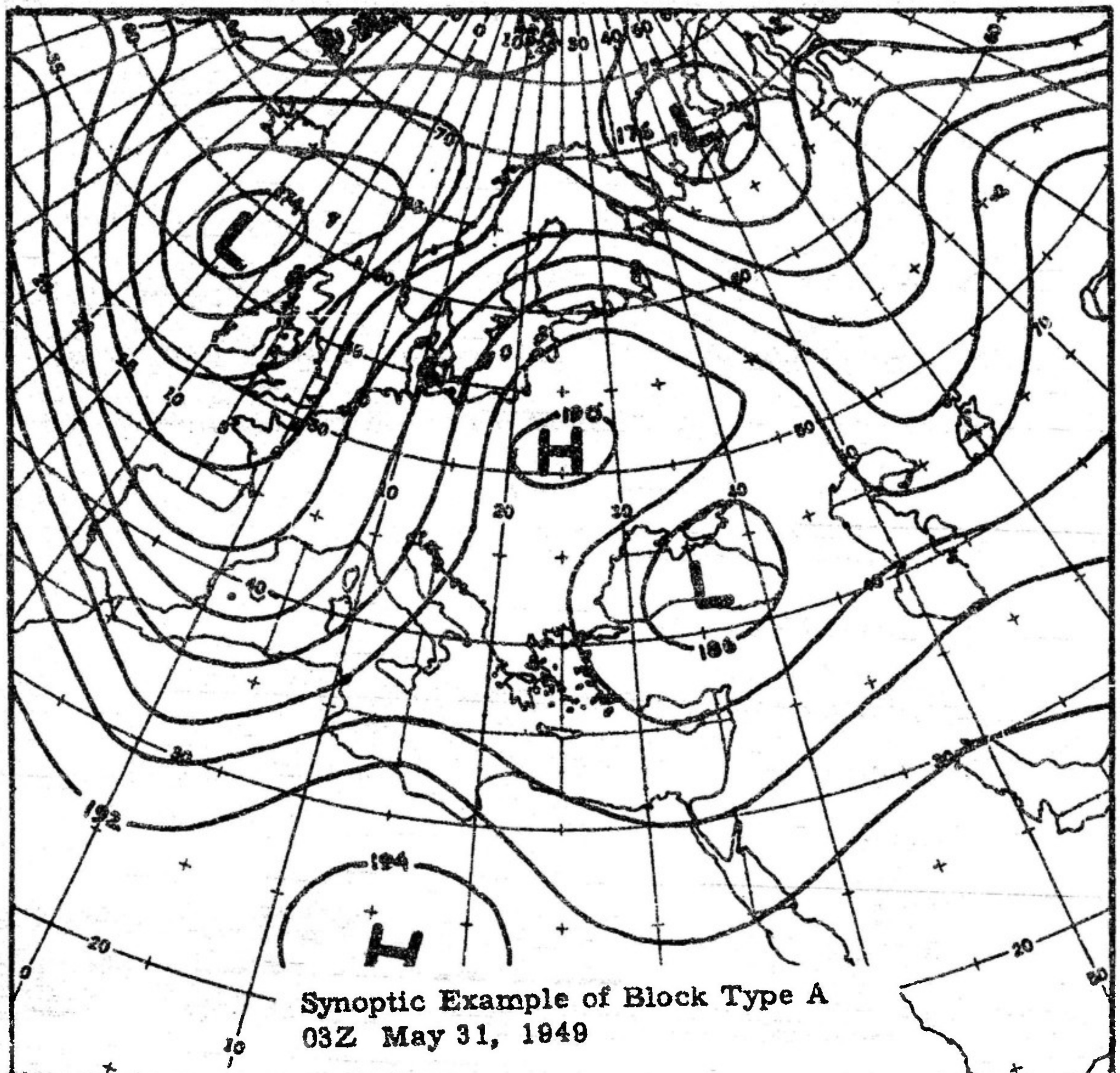


Synoptic Example of Block Type B
03Z May 10, 1949

Figure (13). Block after Rex (B Type)



Schematic Diagram of Block Type A



Synoptic Example of Block Type A
03Z May 31, 1949

Figure (14). Block after Elliott (A Type)

than the others. He states that a retrogression of 60° λ per week is to be expected.

2. Definition

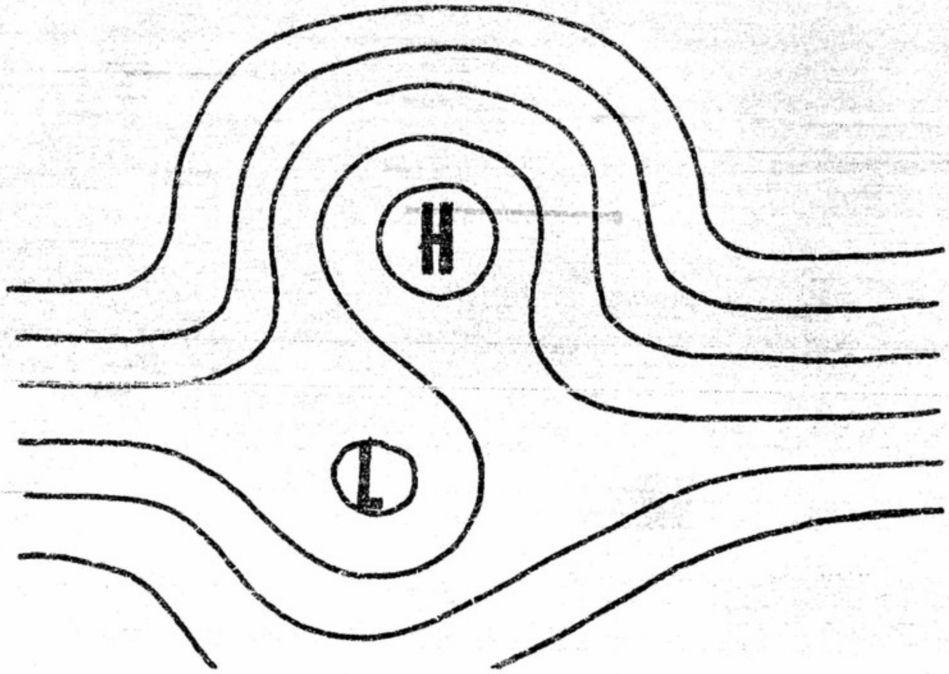
A truly objective description of blocking, then, is yet to be found. In an attempt to arrive at one, daily block patterns from 500-mb contour charts were placed in one of three categories, designated A, B, and AB. These patterns are illustrated in Figures 13, 14, and 15 and their geographic distribution in Figure 16. The considerable statistical work this process involved has not greatly clarified the problem of definition.

When five-day mean charts were drawn for stable blocking situations, it was observed that a stable block persistently of one type on each of the five charts would, on the mean chart, appear as a different type. In most cases a Rex-type B or AB block would change to an A block.

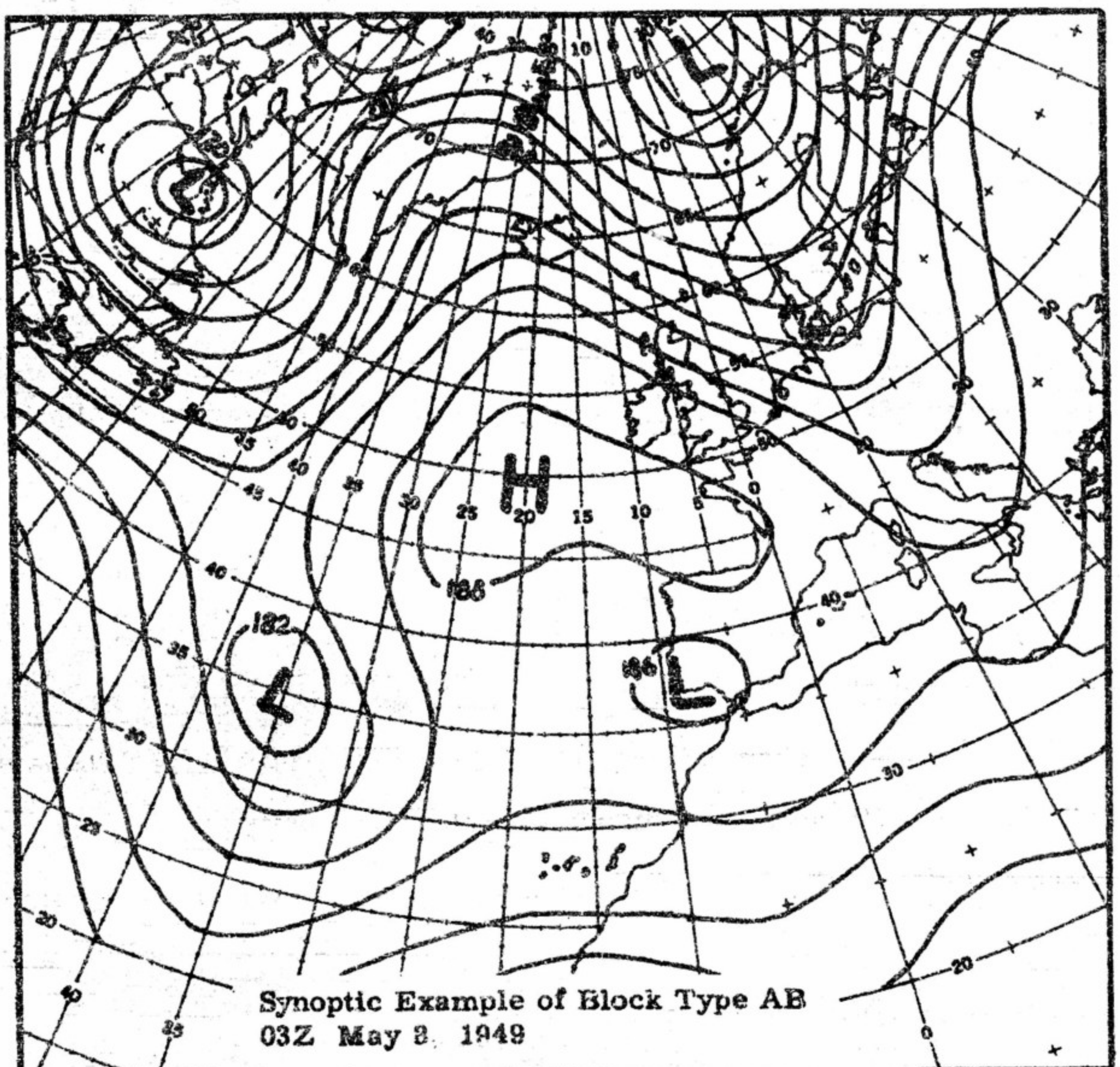
In view of this fact, Elliott's definition seems more realistic than the others. A search for a formula even more precise, which will include ideas by both Elliott and Namias, is being carried out on the basis of space-averaged mean charts.

3. Conclusions

In general, a block may be said to consist of a large plus anomaly at northern latitudes, with an easterly flow frequently evident south of this area. A block may be further considered a long-wave ridge, symmetrical



Schematic Diagram of Block Type AB



Synoptic Example of Block Type AB
03Z May 8, 1949

Figure (15). Composite Block (AB Type)

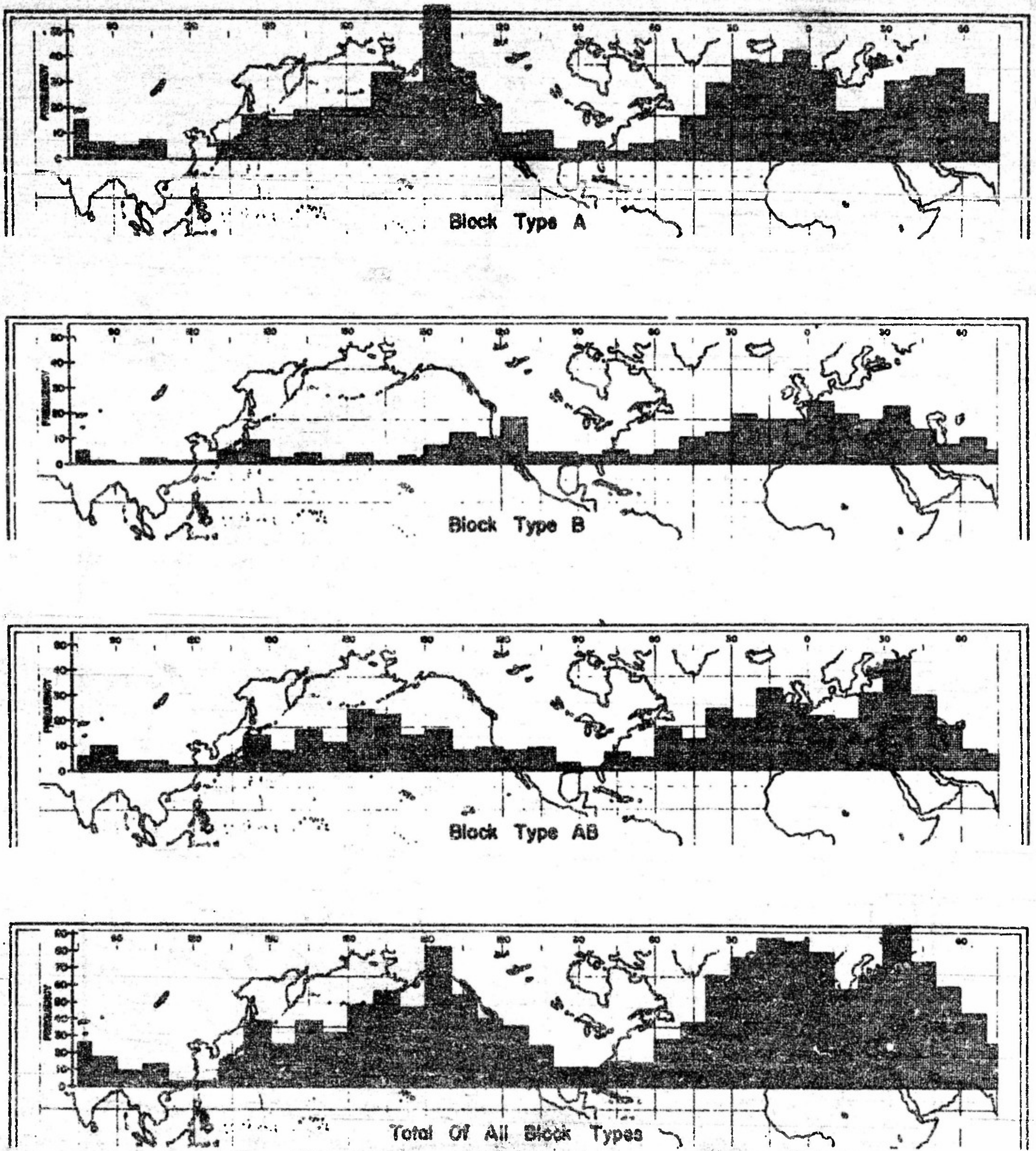


Figure (16). Longitudinal Distribution of Daily Blocks

about a north-south line through the high center, flanked rather closely by two long-wave troughs.

All three types of blocks are common features of daily charts.

V. ZONAL WIND ANALYSIS

1. Historically

Variation in the speed of the west wind is one of the most significant aspects of the atmospheric circulation. Throughout the history of meteorology perhaps no other parameter has been the subject of so much statistical inquiry.

As a major result of studies of surface and 700 millibar general circulation features conducted at Massachusetts Institute of Technology, the existence of "cycles" of west wind speeds was confirmed. High and Low Index phenomena were recognized as meteorological agents conditioning the interpretation of synoptic sequences. More recently, "index cycles," defined as the northward or southward drift of relative maxima of westerly winds, were stressed by Riehl (1) as primary considerations in forecasting for two-day periods.

In discussing the practical use of this concept in a weather central, Snellman (9) has mentioned two serious problems: (1) whether an identifiable trend is present most of the time and (2) the need for an objective analytical technique which will disclose real cycles. Investigations carried out by Project AROWA were meant to remove these difficulties and thus to answer these questions:

(1) How frequently do latitudinal shifts in the relative maxima of westerlies occur?

(2) Which is the best method for analyzing data in terms of index cycles?

(3) What is the historical basis for relating these cycles to forecasting?

2. Data

In accordance with the method for computing zonal profiles outlined in an earlier report (3), daily values of the westerly geostrophic wind were tabulated. The available record, October 1945 through March 1952, was computed in meters per second for each five-degree latitude belt, 10° N to 70° N. Thus virtually all the historic data for the 500-millibar level was assessed, in the belief that only from so large a sample could meaningful averages be drawn.

3. Analysis

Daily values of the geostrophic west wind component were plotted at each latitude band. When sizeable short period fluctuations appeared frequently, a three-day rolling mean was substituted for the individual values and, as expected, most of the short period variations disappeared. Considerable improvement in the consistency of the historical analysis was noted during these years. As a result, two-day averages were successfully used in the data for 1951 and 1952.

Those analyses of current data which are produced under opera-

tional conditions vary considerably and a further "smoothing" of the material with respect to latitude may be required. Values at 67.5° and 62.5° may be averaged and plotted at 65° latitude, those at 62.5° and 57.5° averaged and plotted at 60° latitude, etc.

Table III. - Table IIIa shows unsmoothed, hemispheric values for six consecutive days of November, 1950. At latitude 62.5°N a relative maximum is reached on the 13th, followed by a drop on the 14th, another maximum on the 15th, and a second drop on the 16th. Values at other latitudes show similar short-period waves; at 22.5°N, for example, relative maxima appear on the 13th and 15th. This table is representative of the whole period under study.

In Table IIIb the three-day rolling means, for the same period covered in Table IIIa, have removed the short-term fluctuations. With the hemispheric values showing more gradual changes, small-scale features have been eliminated and the relative maxima and minima accentuated. At latitude 62.5°N, for example, the peaks on both the 13th and 15th have disappeared and the values progress smoothly downward through the period. At latitude 22.5°N, on the other hand, only the relative maximum of the 15th has been smoothed out, while that of the 13th remains significant.

In Table IIIc both temporal and latitudinal adjustments have been effected, that is, the three-day means of Table IIIb have been averaged with respect to latitude and the resulting value plotted for the central latitude. This process established each value in smooth vertical and horizontal

TABLE IIIa. DAILY HEMISPHERIC WESTERLY WINDS
METERS PER SECOND

November 1950 Z-5

Lat/Day	11	12	13	14	15	16
67.5	7.5	8.5	7.2	2.0	0.9	3.8
62.5	7.6	8.9	9.3	6.6	8.1	4.5
57.5	9.9	14.9	12.2	12.0	11.0	8.8
52.5	14.6	14.9	18.0	16.0	13.8	16.1
47.5	18.5	14.4	15.7	20.2	17.6	20.2
42.5	16.5	14.1	13.7	14.6	19.0	20.5
37.5	11.1	12.6	12.8	13.0	15.6	17.0
32.5	8.6	10.9	9.9	12.0	8.6	10.6
27.5	8.9	10.3	12.0	11.6	11.5	7.2
22.5	6.4	5.5	6.5	5.9	8.9	5.5
17.5	3.2	2.0	2.2	5.1	3.6	0.3
12.5	-1.9	2.0	-7.6	-4.7	-3.9	-3.3

TABLE IIIb. THREE-DAY ROLLING AVERAGES OF VALUES
IN TABLE IIIa

November 1950 M-5

Lat/Day	11	12	13	14	15	16
67.5	7.7	5.9	5.9	2.2	2.5	2.8
62.5	8.6	8.3	8.0	6.4	5.1	3.8
57.5	12.3	13.0	11.7	10.6	9.5	7.7
52.5	15.8	16.3	15.9	15.3	15.3	16.0
47.5	16.2	16.8	17.8	19.3	19.7	20.5
42.5	14.8	14.1	15.8	18.0	20.0	19.9
37.5	12.2	12.8	13.8	15.2	16.6	17.1
32.5	9.8	10.9	10.2	10.4	10.2	11.5
27.5	10.4	11.3	11.7	10.1	8.7	8.3
22.5	6.1	6.0	7.1	6.8	6.5	5.9
17.5	2.5	3.1	3.6	3.0	2.0	1.4
12.5	-3.8	-4.8	-5.4	-4.0	-3.1	-2.2

TABLE IIIc. VALUES OF TABLE IIIb SMOOTHED ONCE
WITH LATITUDE

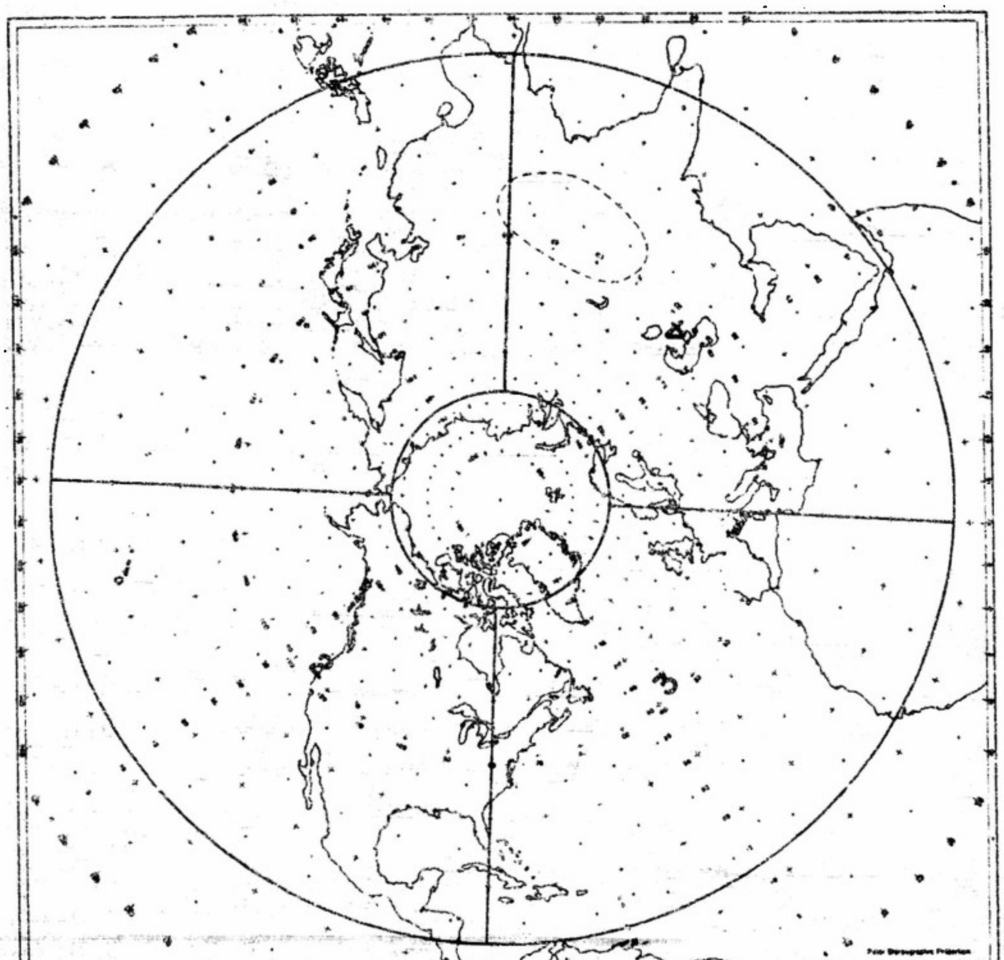
November 1950 M-5/ϕ

Lat/Day	11	12	13	14	15	16
65	8.2	7.1	7.0	4.3	3.8	3.3
60	10.5	10.7	9.9	8.5	7.3	5.8
55	14.1	14.7	13.8	13.0	12.4	11.9
50	16.0	16.6	16.9	17.3	17.5	18.3
45	15.5	15.5	16.8	18.7	19.9	20.2
40	13.5	13.5	14.8	16.6	18.3	18.5
35	11.0	11.9	12.0	12.8	13.4	14.3
30	10.1	11.1	11.0	10.3	9.5	9.9
25	8.3	8.7	9.4	8.5	7.6	7.1
20	4.3	4.6	5.4	4.9	4.3	3.7
15	-.7	-.9	-.9	-.5	-.6	-.4

series, so that the relative maxima and minima which persist constitute recognizable latitudinal trends in the geostrophic flow.

Figures 17 - 21. - Computed from daily values over the period studied, average monthly strengths of the 500-mb westerlies are presented graphically, for each of four "zones" and for the Northern Hemisphere, in Figures17 through 21. The method used to tabulate data and arrange it on punched cards resulted in zones with the following dimensions:

Zone 1 ; 100° East to 170° West
Zone 2 ; 170° West to 80° West
Zone 3 ; 80° West to 10° East
Zone 4 ; 10° East to 100° East



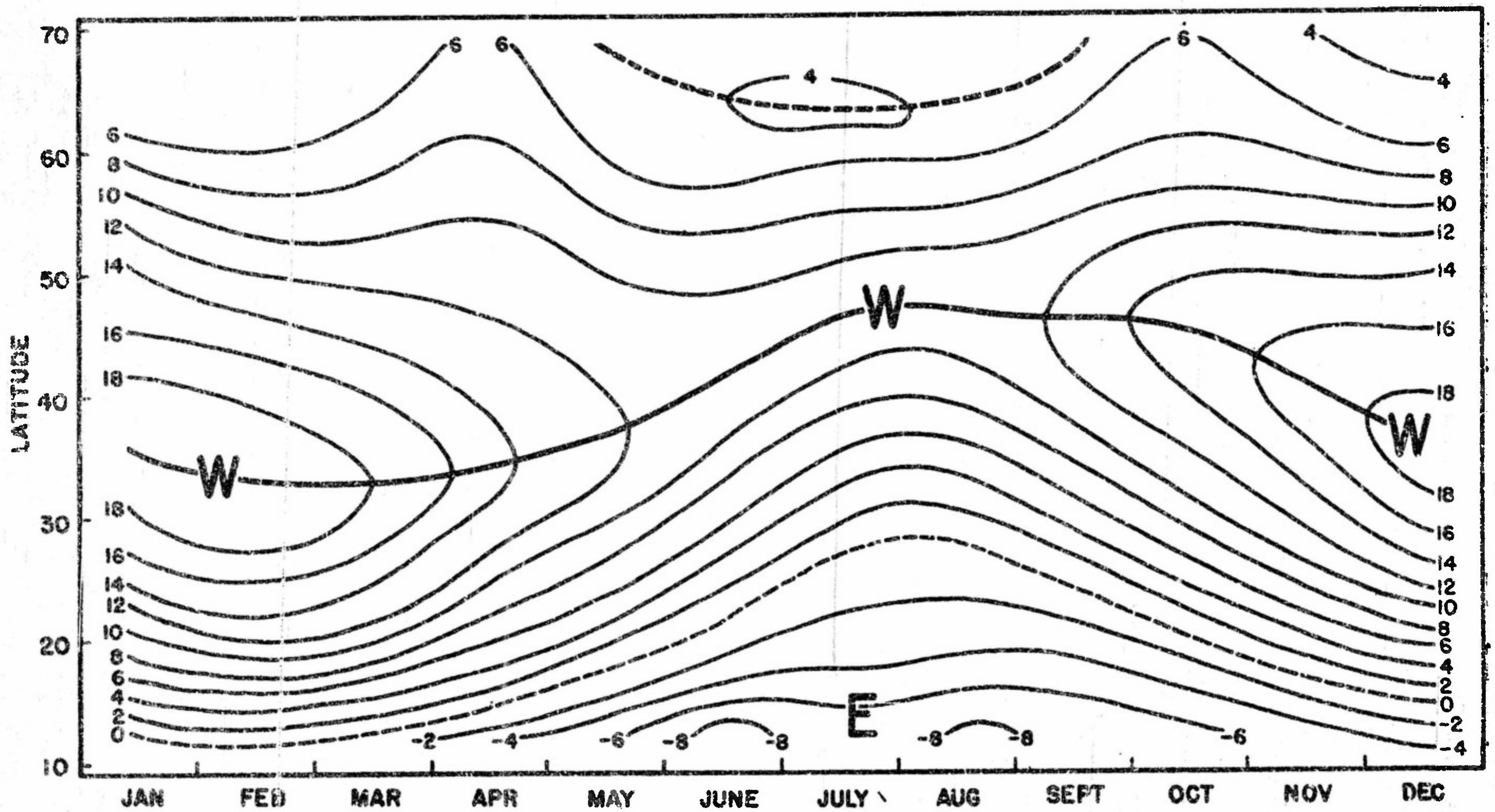


Figure (17). Average Values of 500-mb Geostrophic West Wind Component (hemisphere) Z5, M5

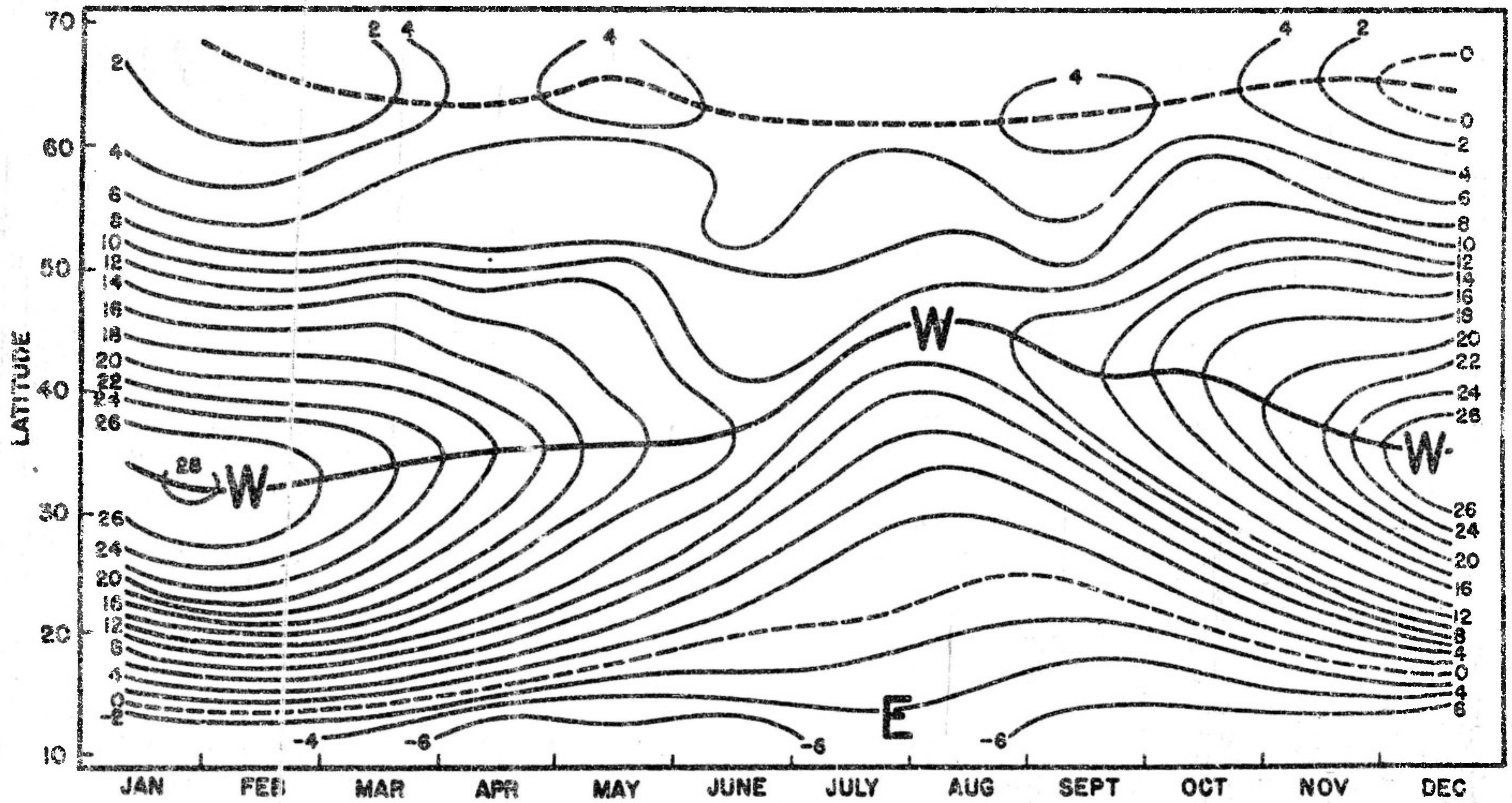


Figure (18). Average Values of 500-mb Geostrophic West Wind Component
(Zone I; 100E to 170W) Z1, M1

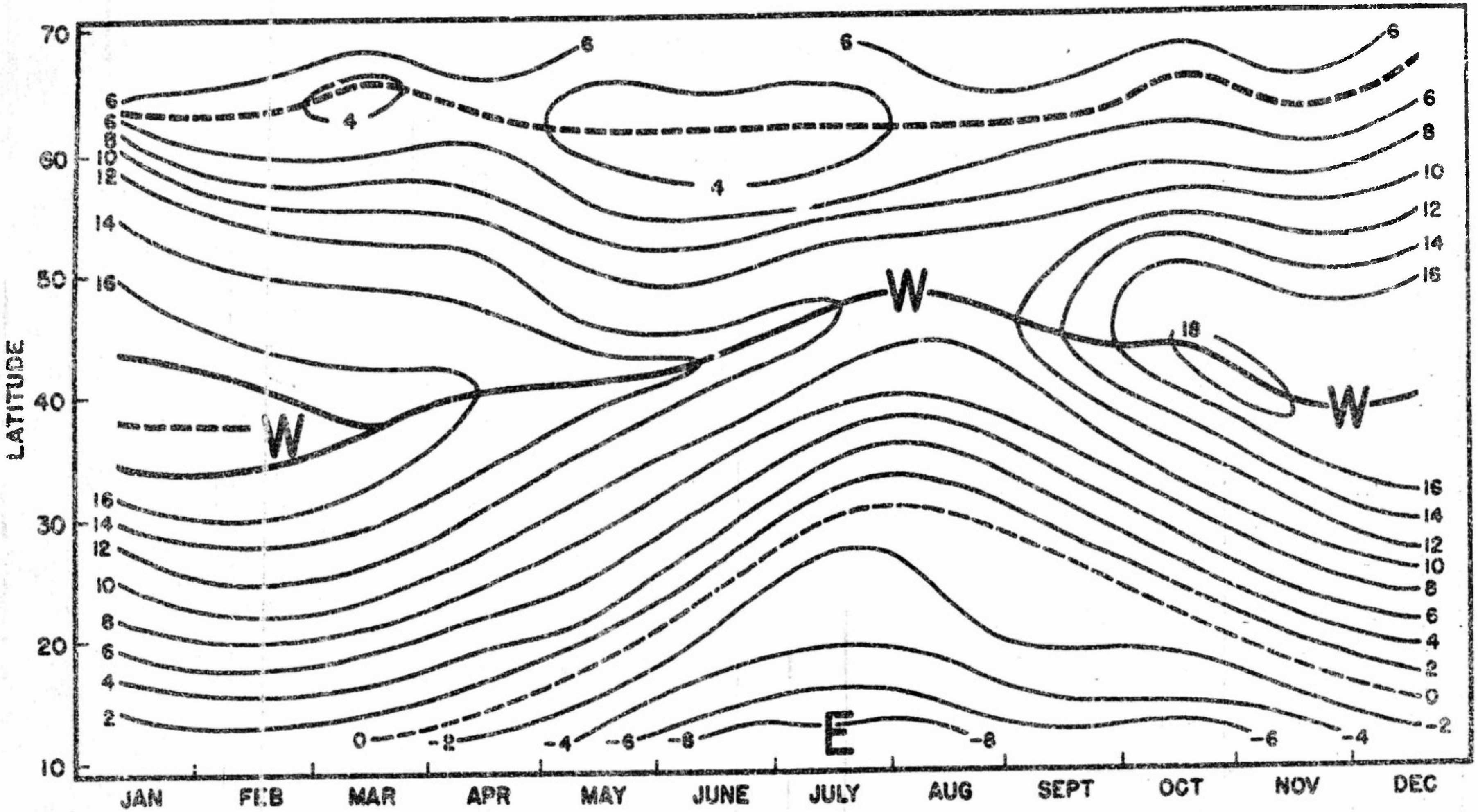


Figure (19). Average Values of 500-mb Geostrophic West Wind Component (Zone 2; 170W to 80W) Z2, M2

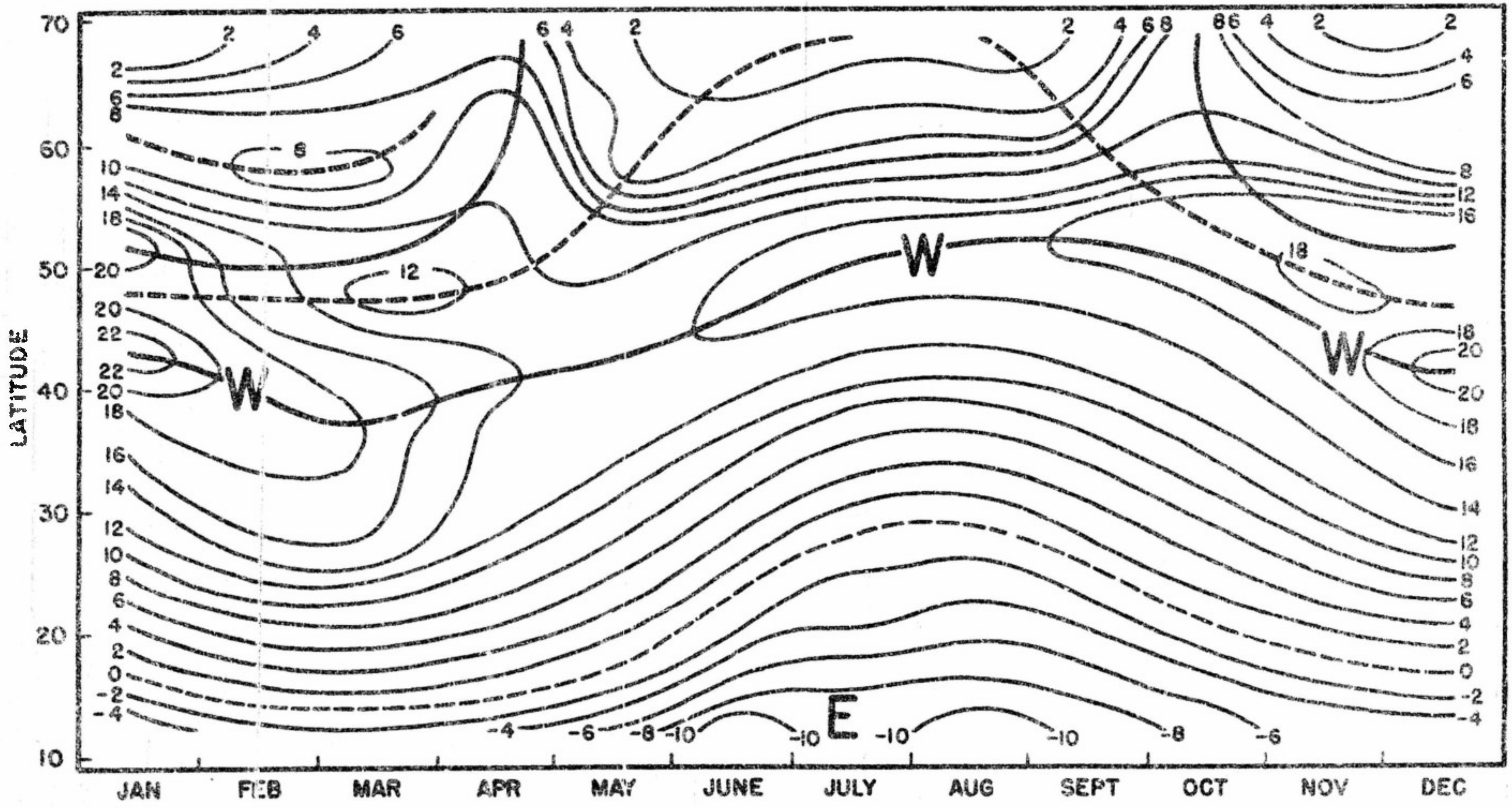


Figure (20). Average Values of 500-mb Geostrophic West Wind Component (Zone 3; 80W to 10E) Z3, M3

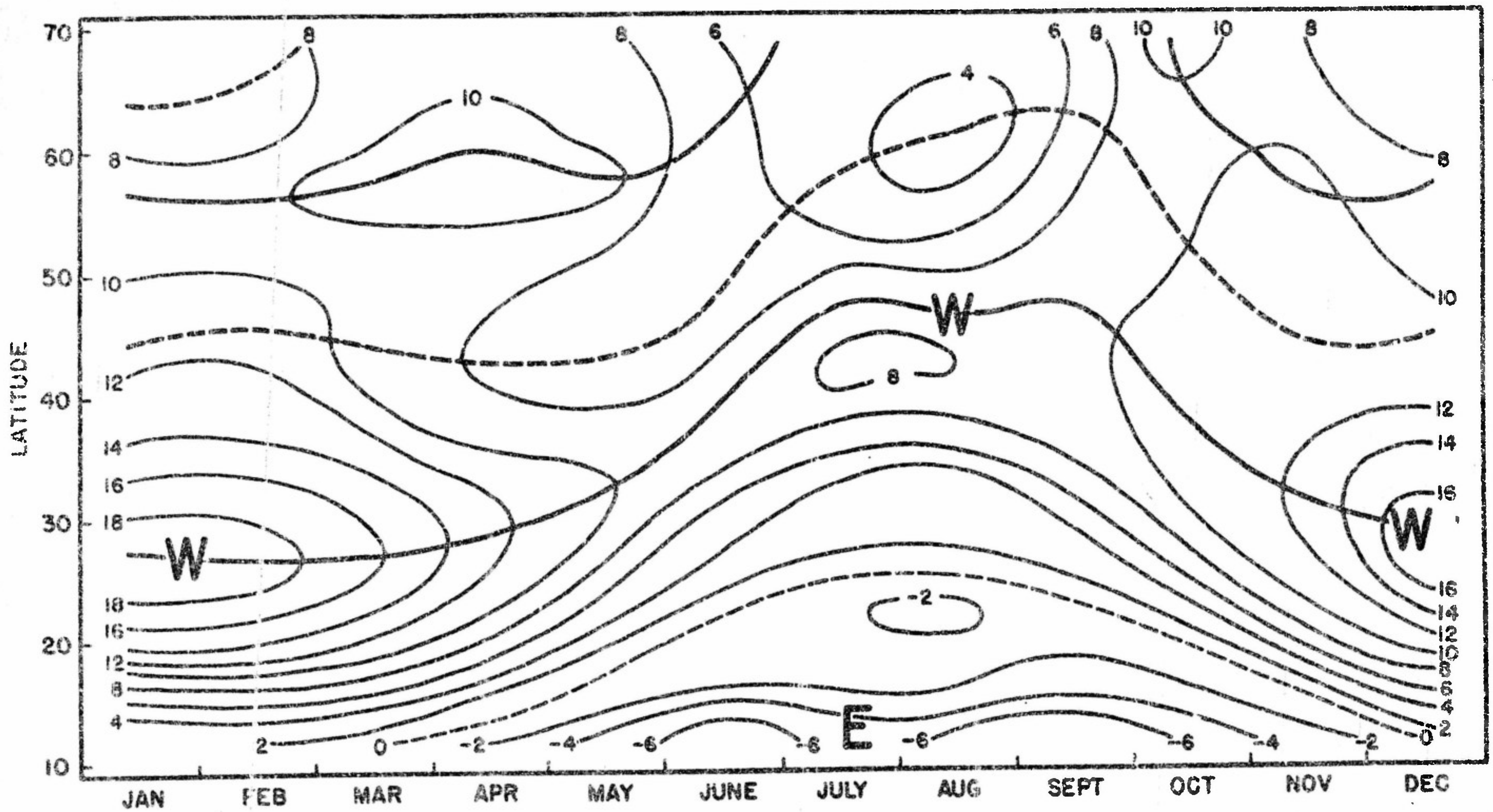


Figure (21). Average Values of 500-mb Geostrophic West Wind Component
(Zone 4; 10E to 100E) Z4, M4

The solid heavy line in these figures represents the mean latitude of maximum winds, the dashed heavy line the mean latitude of minimum winds. Note that hemispheric westerlies are at peak velocities and lowest latitudes during February and March. Thereafter the maximum moves north and, considerably decreased, reaches its northernmost position (about latitude 47°) in July and August. A pronounced southward shift and increased velocities return in October and continue through January.

Geostrophic easterlies at low latitudes reach two maxima, the first in June, the second in late August and early September. At latitude 12.5° N, however, westerlies are in evidence in February. And farther north, at latitudes 62.5° and 67.5°, westerly maxima occur in both April and October, with a minimum intervening in July.

While details of the zonal patterns differ markedly from the hemispheric averages, major features of at least one (Zone III, shown in Figure (20) encompassing the North Atlantic - Western European Area) resemble those of the hemisphere; the low-latitude easterly maxima are again in evidence in June and late August; the westerly maxima of April and October at high latitudes are again separated by an extensive minimum during the summer months.

The latitudinal shift of the maximum is greater in Zone IV (shown in Figure (21) than in the others, with a position near latitude 27° N in January, February, and March. Nevertheless, maxima of the low-

latitude easterlies reappear in June and September, the usual high-latitude minimum occurring in August.

Zone I (Figure 18), covering the West Pacific, shows less latitudinal movement than do the other zones. Maximum westerlies at middle latitudes first shift slightly from a February position at latitude 32° N to a position at latitude 36° N and then more rapidly to an extreme position at latitude 46° N during late July and early August. Note that this zone shows greater speeds for the period October to May than does any other (whereas Zone III shows highest values of the westerly maximum for the summer months).

Table IV. - Three-day rolling means of west-wind speeds for the same month of each year were arrayed latitude by latitude. The total number of observations in each monthly sample (180, or 6 x 30, in the case of November, for example) was divided into five equal frequency classes, designated "much above," "above," "normal," "below," and "much below". Table IV shows a sample of determination of class limits for November at latitude 32.5° N. Note that observations grouped in this table are not normally distributed.

Table V. - The monthly class limits were plotted and further divided into limits for five-day periods. Five-day class limits for the hemisphere were thus established (Table V). Figure (22) gives an example of the graphs of wind speeds from which these limits were determined.

Table V thus provides the climatological information needed to compare daily profiles with the normal profile. Although the method used to compile this table was adequate to determine an index cycle description in approximately 60 per cent of the material, it was not quite complete.

Table VI. - (For an explanation of Table VIa, cf. Table IIIb above.) Hemispheric class limits (Table V) were used to define

TABLE IV. EXAMPLE OF DETERMINATION OF CLASS LIMITS
(Latitude 32.5° N - Six Years Data for November in m sec^{-1})

Classmark	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5	16.5	17.5	18.5
Number in Class	2	4	12	12	11	8	29	35	29	29	9
Cumulative Frequency	2	6	18	30	41	49	78	113	142	171	180
Cumulative $\frac{N}{5}$					36		72	108		144	
Limits of Class					12.5		14.8	15.9		17.1	

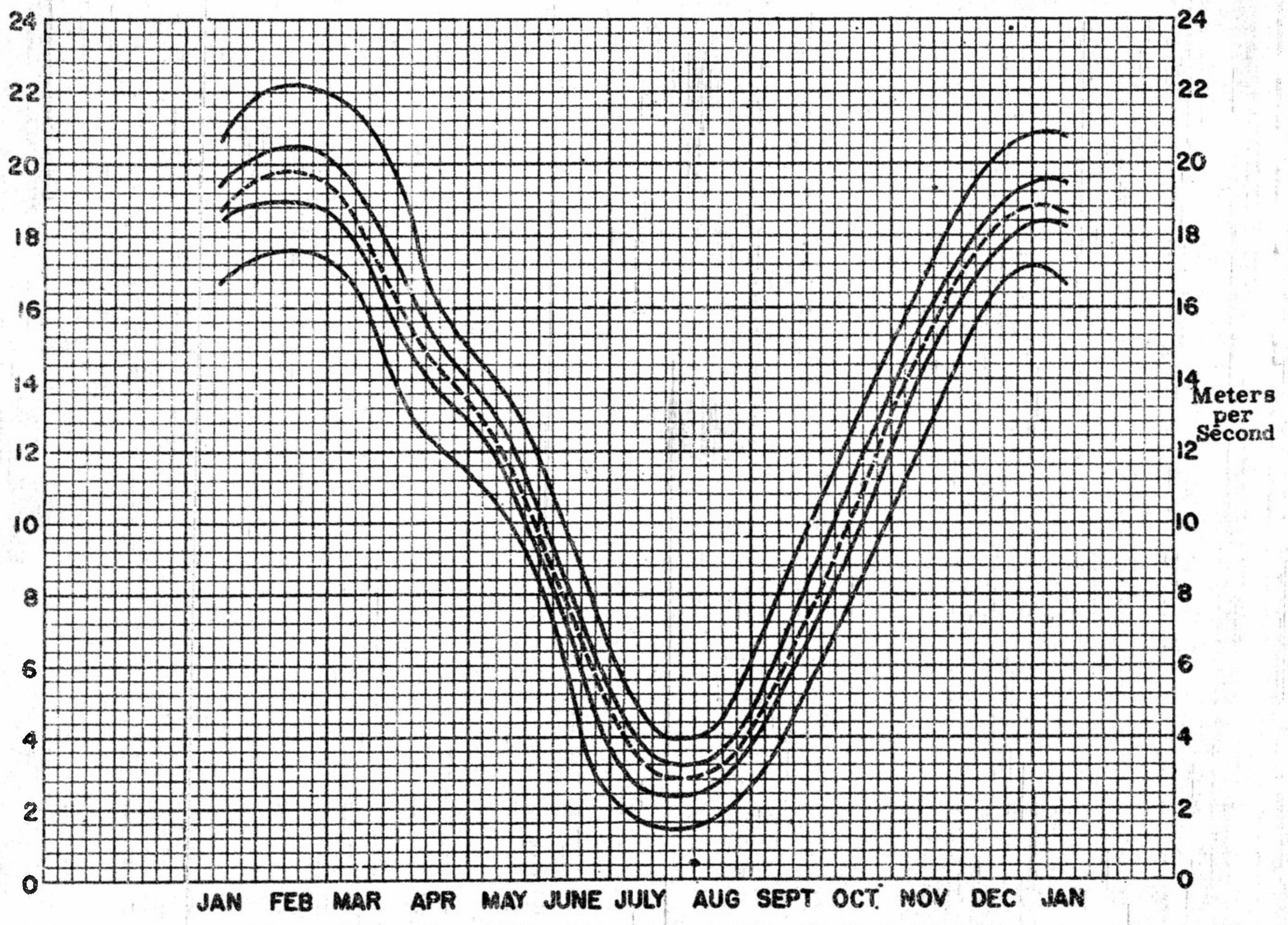


Figure (22). Plot of Class Limits for M-5 for Latitude 32.5°N

TABLE V

CLASS LIMITS FOR HEMISPHERIC ZONAL WIND ANALYSIS
(meters per second)

Period 1-5 Month January Years 46,47,48,49,50,51,52

LAT.	MB	B	N	A	MA
67.5	0.4	0.5 2.6	2.7 4.6	4.7 6.9	7.0
62.5	1.9	2.0 3.7	3.8 6.2	6.3 8.8	8.9
57.5	4.7	4.8 7.0	7.1 9.8	9.9 12.3	12.4
52.5	9.3	9.4 11.7	11.8 13.4	13.5 15.4	15.5
47.5	13.2	13.3 15.0	15.1 16.5	16.6 17.8	17.9
42.5	15.8	15.9 17.1	17.2 18.6	18.7 20.2	20.3
37.5	16.7	16.8 18.5	18.6 19.9	20.0 21.7	21.8
32.5	16.7	16.8 18.2	18.3 19.4	19.5 20.6	20.7
27.5	14.9	15.0 15.9	16.0 16.9	17.0 18.0	18.1
22.5	9.7	9.8 11.5	11.6 12.9	13.0 14.2	14.3
17.5	3.4	3.5 4.8	4.9 6.4	6.5 7.9	8.0
12.5	-4.3	-4.2 -3.4	-3.3 -1.0	-0.9 0.4	0.5

Period 6-10 Month January Years 46,47,48,49,50,51,52

LAT.	MB	B	N	A	MA
67.5	0.8	0.9 2.9	3.0 4.7	4.8 7.1	7.2
62.5	2.3	2.4 3.9	4.0 5.9	6.0 9.0	9.1
57.5	5.0	5.1 7.3	7.4 10.0	10.1 12.6	12.7
52.5	9.7	9.8 11.7	11.8 13.8	13.9 15.6	15.7
47.5	13.3	13.4 15.2	15.3 16.8	16.9 18.0	18.1
42.5	15.9	16.0 17.2	17.3 18.7	18.8 20.4	20.5
37.5	16.7	16.8 18.6	18.7 19.9	20.0 21.5	21.6
32.5	16.7	16.8 18.2	18.3 19.4	19.5 20.7	20.8
27.5	15.0	15.1 16.1	16.2 17.0	17.1 18.2	18.3
22.5	10.0	10.1 11.8	11.9 13.3	13.4 14.6	14.7
17.5	3.6	3.7 5.2	5.3 6.8	6.9 8.3	8.4
12.5	-4.1	-4.0 -2.6	-2.5 -0.7	-0.6 0.8	0.9

Period 11-15 Month January Years 46,47,48,49,50,51,52

LAT.	MB	B	N	A	MA
67.5	1.2	1.3 3.1	3.2 4.7	4.8 7.2	7.3
62.5	2.7	2.8 4.0	4.1 5.7	5.8 9.1	9.2
57.5	5.3	5.4 7.6	7.7 10.1	10.2 12.8	12.9
52.5	9.9	10.0 11.8	11.9 14.1	14.2 15.7	15.8
47.5	13.5	13.6 15.5	15.6 17.0	17.1 18.2	18.3
42.5	16.0	16.1 17.3	17.4 18.7	18.8 20.5	20.6
37.5	16.8	16.9 18.7	18.8 19.9	20.0 21.2	21.3
32.5	16.7	16.8 18.3	18.4 19.5	19.6 20.7	20.8
27.5	15.2	15.3 16.2	16.3 17.1	17.2 18.3	18.4
22.5	10.4	10.5 12.2	12.3 13.8	13.9 15.0	15.1
17.5	3.9	4.0 5.6	5.7 7.2	7.3 8.7	8.8
12.5	-3.8	-3.7 -2.4	-2.3 -0.4	-0.3 1.2	1.3

Period 16-20 Month January Years 46,47,48,49,50,51,52

LAT.	MB	B	N	A	MA
67.5	1.4	1.5 3.0	3.1 4.8	4.9 7.3	7.4
62.5	2.7	2.8 4.1	4.2 5.7	5.8 9.1	9.2
57.5	4.9	5.0 7.6	7.7 9.9	10.0 12.7	12.8
52.5	9.5	9.6 11.6	11.7 14.1	14.2 15.7	15.8
47.5	13.2	13.3 15.5	15.6 17.2	17.3 18.4	18.5
42.5	15.8	15.9 17.3	17.4 18.7	18.8 20.4	20.5
37.5	16.9	17.0 18.7	18.8 19.8	19.9 21.1	21.2
32.5	16.7	16.8 18.3	18.4 19.7	19.8 20.9	21.0
27.5	15.4	15.5 16.4	16.5 17.6	17.7 18.9	19.0
22.5	10.7	10.8 12.6	12.7 14.0	14.1 15.4	15.5
17.5	4.1	4.2 5.8	5.9 7.4	7.5 9.1	9.2
12.5	-3.6	-3.5 -2.1	-2.0 -0.5	-0.4 1.4	1.5

Period 21-25 Month January Years 46,47,48,49,50,51,52

LAT.	MB	B	N	A	MA
67.5	1.4	1.5 3.1	3.2 4.9	5.0 7.2	7.3
62.5	2.6	2.7 4.0	4.1 5.9	6.0 8.8	8.9
57.5	4.4	4.5 7.4	7.5 9.6	9.7 13.0	13.1
52.5	8.3	8.4 11.2	11.3 13.8	13.9 15.4	15.5
47.5	12.4	12.5 15.1	15.2 16.9	17.0 18.1	18.2
42.5	15.2	15.3 17.0	17.1 18.5	18.6 19.9	20.0
37.5	17.0	17.1 18.7	18.8 19.8	19.9 21.0	21.1
32.5	16.9	17.0 18.4	18.5 20.0	20.1 21.3	21.4
27.5	15.7	15.8 16.7	16.8 18.2	18.3 19.7	19.8
22.5	11.1	11.2 12.8	12.9 14.4	14.5 15.9	16.0
17.5	4.2	4.3 5.9	6.0 7.4	7.5 9.4	9.5
12.5	-3.3	-3.2 -1.7	-1.6 0.2	0.3 1.6	1.7

Period 26-31 Month January Years 46,47,48,49,50,51,52

LAT.	MB	B	N	A	MA
67.5	1.4	1.5 3.1	3.2 4.9	5.0 7.1	7.2
62.5	2.5	2.6 4.0	4.1 6.0	6.1 8.7	8.8
57.5	4.0	4.1 7.3	7.4 9.4	9.5 11.6	11.7
52.5	7.7	7.8 11.0	11.1 13.6	13.7 15.2	15.3
47.5	11.9	12.0 14.8	14.9 16.6	16.7 17.6	17.7
42.5	14.9	15.0 16.7	16.8 18.3	18.4 19.7	19.8
37.5	17.0	17.1 18.7	18.8 19.8	19.9 21.0	21.1
32.5	17.0	17.1 18.4	18.5 20.1	20.2 21.6	21.7
27.5	15.8	15.9 16.9	17.0 18.6	18.7 20.0	20.1
22.5	11.4	11.5 13.0	13.1 14.6	14.7 16.2	16.3
17.5	4.3	4.4 6.0	6.1 7.5	7.6 9.6	9.7
12.5	-3.2	-3.1 -1.5	-1.4 0.4	0.5 1.7	1.8

TABLE V. (Continued)

CLASS LIMITS FOR HEMISPHERIC ZONAL WIND ANALYSIS
(meters per second)

Period 1-5 Month February Years 46,47,48,49,50,51,52

LAT.	MB	B		N		A		MA
67.5	1.5	1.6	3.1	3.2	5.0	5.1	7.1	7.2
62.5	2.4	2.5	4.1	4.2	6.2	6.3	8.5	8.6
57.5	3.5	3.6	7.1	7.2	9.1	9.2	11.0	11.1
52.5	7.0	7.1	10.7	10.8	13.1	13.2	14.8	14.9
47.5	11.2	11.3	14.4	14.5	16.3	16.4	17.6	17.7
42.5	14.4	14.5	16.4	16.5	18.0	18.1	19.1	19.2
37.5	17.0	17.1	18.6	18.7	19.7	19.8	20.9	21.0
32.5	17.1	17.2	18.5	18.6	20.3	20.4	21.9	22.0
27.5	16.0	16.1	17.2	17.3	18.9	19.0	20.5	20.6
22.5	11.7	12.8	13.2	13.3	14.8	14.9	16.6	16.7
17.5	4.4	4.5	6.1	6.2	7.7	7.8	9.8	9.9
12.5	-3.0	-2.9	-1.2	-1.1	0.5	0.6	2.0	2.1

Period 6-10 Month February Years 46,47,48,49,50,51,52

LAT.	MB	B		N		A		MA
67.5	1.5	1.6	3.1	3.2	5.1	5.2	7.1	7.2
62.5	2.3	2.4	4.1	4.2	6.4	6.5	8.4	8.5
57.5	3.2	3.3	6.9	7.0	8.8	8.9	10.6	10.7
52.5	6.4	6.5	10.4	10.5	12.7	12.8	14.5	14.6
47.5	10.8	10.9	14.1	14.2	15.9	16.0	17.3	17.4
42.5	14.0	14.1	15.1	15.2	17.7	17.8	18.9	19.0
37.5	16.9	17.0	18.5	18.6	19.6	19.7	20.9	21.0
32.5	17.2	17.3	18.7	18.8	20.4	20.5	22.0	22.1
27.5	16.1	16.2	17.3	17.4	19.2	19.3	21.0	21.1
22.5	11.9	12.0	13.3	13.4	15.0	15.1	16.9	17.0
17.5	4.5	4.6	6.2	6.3	7.7	7.8	10.0	10.1
12.5	-2.9	-2.8	-1.9	-1.8	0.7	0.8	2.2	2.3

Period 11-15 Month February Years 46,47,48,49,50,51,52

LAT.	MB	B		N		A		MA
67.5	1.6	1.7	3.2	3.3	5.2	5.3	7.1	7.2
62.5	2.2	2.3	4.2	4.3	6.5	6.6	8.3	8.4
57.5	3.0	3.1	6.8	6.9	8.7	8.8	10.5	10.6
52.5	6.1	6.2	10.2	10.3	12.4	12.5	14.3	14.4
47.5	10.6	10.7	13.8	13.9	15.7	15.8	17.0	17.1
42.5	13.8	13.9	15.8	15.9	17.6	17.7	18.7	18.8
37.5	16.9	17.0	18.4	18.5	19.5	19.6	20.8	20.9
32.5	17.3	17.4	18.7	18.8	20.4	20.5	22.2	22.3
27.5	16.1	16.2	17.3	17.4	19.4	19.5	21.2	21.3
22.5	12.0	12.1	13.5	13.6	15.2	15.3	17.1	17.2
17.5	4.5	4.6	6.3	6.4	7.8	7.9	10.0	10.1
12.5	-2.9	-2.8	-0.8	-0.7	0.8	0.9	2.3	2.4

Period 16-20 Month February Years 46,47,48,49,50,51,52

LAT.	MB	B		N		A		MA
67.5	1.6	1.7	3.2	3.3	5.3	5.4	7.1	7.2
62.5	2.2	2.3	4.2	4.3	6.7	6.8	8.3	8.4
57.5	3.1	3.2	6.8	6.9	8.7	8.8	10.4	10.5
52.5	6.0	6.1	9.9	10.0	12.0	12.1	14.0	14.1
47.5	10.4	10.5	13.4	13.5	15.3	15.4	18.7	18.8
42.5	13.7	13.8	15.5	15.6	17.3	17.4	18.4	18.5
37.5	16.7	16.8	18.3	18.4	19.4	19.5	20.7	20.8
32.5	17.3	17.4	18.7	18.8	20.4	20.5	22.3	22.4
27.5	16.1	16.2	17.4	17.5	19.3	19.4	21.2	21.3
22.5	11.9	12.0	13.4	13.5	15.1	15.2	17.0	17.1
17.5	4.5	4.6	6.3	6.4	7.8	7.9	10.1	10.2
12.5	-2.9	-2.8	-0.7	-0.6	0.8	0.9	2.4	2.5

Period 21-25 Month February Years 46,47,48,49,50,51,52

LAT.	MB	B		N		A		MA
67.5	1.7	1.8	3.3	3.4	5.4	5.5	7.2	7.3
62.5	2.3	2.4	4.4	4.5	6.8	6.9	8.4	8.5
57.5	3.3	3.4	6.8	6.9	8.7	8.8	10.5	10.6
52.5	6.1	6.2	9.6	9.7	11.8	11.9	13.7	13.8
47.5	10.3	10.4	13.0	13.1	16.0	16.1	18.4	18.5
42.5	13.5	13.6	15.2	15.3	17.0	17.1	18.2	18.3
37.5	16.6	16.7	18.0	18.1	19.2	19.3	20.6	20.7
32.5	17.3	17.4	18.6	18.7	20.2	20.3	22.3	22.4
27.5	16.1	16.2	17.3	17.4	19.1	19.2	21.0	21.1
22.5	11.8	11.9	13.1	13.2	14.9	15.0	16.9	17.0
17.5	4.4	4.5	6.3	6.4	7.8	7.9	10.0	10.1
12.5	-3.3	-3.2	-0.9	-0.8	0.8	0.9	2.3	2.4

Period 26-28 Month February Years 46,47,48,49,50,51,52

LAT.	MB	B		N		/		MA
67.5	1.8	1.9	3.4	3.5	5.6	5.7	7.3	7.4
62.5	2.4	2.5	4.5	4.6	6.9	7.0	8.6	8.7
57.5	3.4	3.5	6.8	6.9	8.8	8.9	10.6	10.7
52.5	6.2	6.3	9.5	9.6	11.6	11.7	13.6	13.7
47.5	10.2	10.3	12.8	12.9	14.8	14.9	16.2	16.3
42.5	13.4	13.5	15.4	15.5	16.8	16.9	18.1	18.2
37.5	16.4	16.5	17.8	17.9	19.1	19.2	20.6	20.7
32.5	17.2	17.3	18.6	18.7	20.1	20.2	22.2	22.3
27.5	15.9	16.0	17.2	17.3	18.9	19.0	20.7	20.8
22.5	11.4	11.5	12.9	13.0	14.8	14.9	16.6	16.7
17.5	4.3	4.4	6.2	6.3	7.7	7.8	9.9	10.0
12.5	-3.3	-3.2	-1.0	-0.9	0.8	0.9	2.3	2.4

TABLE V. (Continued)

CLASS LIMITS FOR HEMISPHERIC ZONAL WIND ANALYSIS

(meters per second)

Period 1-5 Month March Years 46, 47, 48, 49, 50, 51, 52

LAT.	MB	B	N	A	MA
67.5	1.9	2.0 3.3	3.6 5.8	5.9 7.4	7.5
62.5	2.7	2.8 4.7	4.8 7.1	7.2 8.8	8.9
57.5	3.8	3.9 6.9	7.0 8.9	9.0 10.8	10.9
52.5	6.4	6.5 9.2	9.3 11.5	11.6 13.4	13.5
47.5	10.1	10.2 12.4	12.5 14.4	14.5 15.9	16.0
42.5	13.3	13.4 14.7	14.8 16.0	16.1 17.9	18.0
37.5	16.0	16.1 17.4	17.5 18.8	18.9 20.4	20.5
32.5	17.1	17.2 18.4	18.5 19.8	19.9 22.0	22.1
27.5	15.5	15.6 16.9	17.0 18.4	18.5 20.1	20.2
22.5	10.7	10.8 12.3	12.4 14.5	14.6 16.0	16.1
17.5	4.2	4.3 6.0	6.1 7.6	7.7 9.6	9.7
12.5	-4.1	-4.0 -1.3	-1.2 0.8	0.9 2.1	2.2

Period 6-10 Month March Years 46, 47, 48, 49, 50, 51, 52

LAT.	MB	B	N	A	MA
67.5	2.0	2.1 3.6	3.7 6.0	6.1 7.6	7.7
62.5	3.0	3.1 4.9	5.0 7.3	7.4 9.1	9.2
57.5	4.2	4.3 7.0	7.1 7.9	8.0 11.0	11.1
52.5	6.6	6.7 8.1	8.2 11.4	11.5 13.3	13.4
47.5	10.1	10.2 12.1	12.2 14.1	14.2 15.6	15.7
42.5	13.2	13.3 14.4	14.5 16.2	16.3 17.8	17.9
37.5	15.7	15.8 17.1	17.2 18.6	18.7 20.2	20.3
32.5	16.7	16.8 18.1	18.2 19.6	19.7 21.7	21.8
27.5	15.2	15.3 16.4	16.5 18.0	18.1 19.7	19.8
22.5	10.1	10.2 12.0	12.1 14.3	14.4 15.7	15.8
17.5	4.0	4.1 5.8	5.9 7.4	7.5 9.3	9.4
12.5	-4.5	-4.4 -1.5	-1.4 0.6	0.7 2.0	2.1

Period 11-15 Month March Years 46, 47, 48, 49, 50, 51, 52

LAT.	MB	B	N	A	MA
67.5	2.1	2.2 3.6	3.7 6.3	6.4 7.8	7.9
62.5	3.3	3.4 5.2	5.3 7.4	7.5 9.3	9.4
57.5	4.5	4.6 7.0	7.1 9.0	9.1 11.1	11.2
52.5	6.9	7.0 9.1	9.2 11.4	11.5 13.2	13.3
47.5	10.0	10.1 11.9	12.0 13.7	13.8 15.3	15.4
42.5	13.0	13.1 14.1	14.2 15.9	16.0 17.3	17.4
37.5	15.3	15.4 16.7	16.8 18.3	18.4 20.0	20.1
32.5	16.5	16.6 17.8	17.9 19.3	19.4 21.5	21.6
27.5	14.8	14.9 16.0	16.1 17.6	17.7 19.3	19.4
22.5	9.6	9.7 11.5	11.6 13.9	14.0 15.4	15.5
17.5	3.7	3.8 5.6	5.7 7.3	7.4 9.1	9.2
12.5	-4.9	-4.8 -1.7	-1.6 0.4	0.5 1.8	1.9

Period 16-20 Month March Years 46, 47, 48, 49, 50, 51, 52

LAT.	MB	B	N	A	MA
67.5	2.3	2.4 3.8	3.9 5.6	5.7 6.1	6.2
62.5	5.7	5.8 7.4	7.5 8.9	9.0 10.3	10.4
57.5	4.9	5.0 7.2	7.3 9.2	9.3 11.3	11.4
52.5	7.1	7.2 9.2	9.3 11.4	11.5 13.1	13.2
47.5	10.0	10.1 11.8	11.9 13.5	13.6 15.1	15.2
42.5	13.8	12.9 [illegible]	13.9 15.6	15.7 17.2	17.3
37.5	14.6	14.7 15.1	15.2 17.8	17.9 19.6	19.7
32.5	15.5	15.8 16.9	17.0 18.6	18.7 20.8	20.9
27.5	14.0	14.1 15.3	15.4 17.8	17.9 18.7	18.8
22.5	9.0	9.1 10.9	11.0 13.3	13.4 14.8	14.9
17.5	3.2	3.3 5.3	5.4 7.0	7.1 8.6	8.7
12.5	-5.5	-5.4 -2.2	-2.1 0.1	0.2 1.6	1.7

Period 21-25 Month March Years 46, 47, 48, 49, 50, 51, 52

LAT.	MB	B	N	A	MA
67.5	2.5	2.6 4.1	4.2 6.9	7.0 8.4	8.5
62.5	4.1	4.2 5.8	5.9 7.9	8.0 9.7	9.8
57.5	5.4	5.5 7.5	7.6 9.4	9.5 11.5	11.6
52.5	7.4	7.5 9.4	9.5 11.5	11.6 13.1	13.2
47.5	9.9	10.0 11.7	11.8 13.3	13.4 14.9	15.0
42.5	12.5	12.6 13.6	13.7 15.3	15.4 16.8	16.9
37.5	14.0	14.1 15.6	15.7 17.3	17.4 19.0	19.1
32.5	14.5	14.6 16.3	16.4 17.9	18.0 20.2	20.3
27.5	13.1	13.2 14.6	14.7 16.3	16.4 18.2	18.3
22.5	8.4	8.5 10.4	10.5 12.6	12.7 14.4	14.5
17.5	2.5	2.6 4.8	4.9 6.7	6.8 8.2	8.3
12.5	-5.9	-5.8 -2.6	-2.5 -0.2	-0.1 1.3	1.4

Period 26-31 Month March Years 46, 47, 48, 49, 50, 51, 52

LAT.	MB	B	N	A	MA
67.5	2.8	2.9 4.3	4.4 7.2	7.3 8.7	8.8
62.5	4.4	4.5 6.2	6.3 8.1	8.2 9.9	10.0
57.5	5.9	6.0 7.9	8.0 9.6	9.7 11.6	11.7
52.5	7.8	7.9 9.6	9.7 11.5	11.6 13.2	13.3
47.5	10.0	10.1 11.6	11.7 13.2	13.3 14.8	14.9
42.5	12.3	12.4 13.4	13.5 15.0	15.1 16.4	16.5
37.5	13.6	13.7 14.9	15.0 16.7	16.8 18.3	18.4
32.5	11.6	11.7 13.1	13.2 14.5	14.6 15.2	15.3
27.5	9.4	9.5 11.8	11.9 12.0	12.1 13.3	13.4
22.5	5.1	5.2 6.5	6.6 7.8	7.9 9.5	9.6
17.5	1.9	2.0 4.4	4.5 6.3	6.4 7.9	8.0
12.5	-6.3	-6.2 -3.0	-2.9 -0.6	-0.5 0.5	0.6

TABLE V. (Continued)

CLASS LIMITS FOR HEMISPHERIC ZONAL WIND ANALYSIS

(meters per second)

Period 1-5 Month April Years 46, 47, 49, 50, 51

LAT.	MB	B	N	A	MA
67.5	3.3	3.4 4.8	4.9 7.6	7.7 9.0	9.1
62.5	5.1	5.2 6.7	6.8 8.4	8.5 10.1	10.2
57.5	6.4	6.5 8.3	8.4 9.9	10.0 11.9	12.0
52.5	8.1	8.3 9.8	9.9 11.5	11.6 13.3	13.4
47.5	10.0	10.1 11.5	11.6 13.1	13.2 14.6	14.7
42.5	12.0	12.1 13.1	13.2 14.7	14.8 15.9	16.0
37.5	13.1	13.2 14.6	14.7 15.9	16.0 17.3	17.4
32.5	13.1	13.2 14.8	14.9 16.2	16.3 18.0	18.1
27.5	11.4	11.5 12.9	13.0 14.9	15.0 16.7	16.8
22.5	7.2	7.3 9.3	9.4 11.4	11.5 13.2	13.3
17.5	1.3	1.4 3.9	4.0 5.7	5.8 7.4	7.5
12.5	-6.8	-6.7 -3.5	-3.4 -1.2	-1.1 0.5	0.6

Period 6-10 Month April Years 46, 47, 49, 50, 51

LAT.	MB	B	N	A	MA
67.5	4.0	4.1 6.0	6.1 7.7	7.8 9.2	9.3
62.5	5.6	5.7 7.2	7.3 8.8	8.9 10.3	10.4
57.5	6.8	6.9 8.6	8.7 10.1	10.2 12.1	12.2
52.5	8.4	8.5 10.0	10.1 11.5	11.6 13.4	13.5
47.5	10.0	10.1 11.4	11.5 12.9	13.0 14.5	14.6
42.5	11.7	11.8 12.9	13.0 14.3	14.4 15.4	15.5
37.5	12.5	12.6 14.6	14.7 15.2	15.3 16.3	16.4
32.5	12.6	12.7 14.4	14.5 15.7	15.8 17.1	17.2
27.5	10.8	10.9 12.2	12.3 14.2	14.3 16.0	16.1
22.5	8.7	8.8 8.8	8.9 10.5	10.6 12.5	12.6
17.5	0.7	0.8 3.5	3.6 5.2	5.3 6.9	7.0
12.5	-7.1	-7.0 -4.0	-3.9 -1.6	-1.5 0.0	0.1

Period 11-15 Month April Years 46, 47, 49, 50, 51

LAT.	MB	B	N	A	MA
67.5	5.1	5.2 7.0	7.1 7.8	7.9 9.3	9.4
62.5	5.7	5.8 7.5	7.6 9.1	9.2 10.4	10.5
57.5	7.1	7.2 8.8	8.9 10.2	10.3 12.2	12.3
52.5	8.5	8.6 10.1	10.2 11.5	11.6 13.4	13.5
47.5	10.0	10.1 11.3	11.4 12.8	12.9 14.3	14.4
42.5	11.5	11.6 12.7	12.8 14.0	14.1 15.1	15.2
37.5	12.0	12.1 13.8	13.9 14.4	14.5 16.4	16.5
32.5	12.3	12.4 14.0	14.1 15.3	15.4 16.5	16.6
27.5	10.2	10.3 11.7	11.8 13.5	13.6 15.2	15.3
22.5	6.2	6.3 8.2	8.3 9.7	9.8 11.8	11.9
17.5	0.3	0.4 3.0	3.1 4.8	4.9 6.4	6.5
12.5	-7.3	-7.2 -4.3	-4.2 -2.2	-2.1 -0.4	-0.3

Period 16-20 Month April Years 46, 47, 49, 50, 51

LAT.	MB	B	N	A	MA
67.5	5.2	5.3 6.3	6.4 7.7	7.8 9.1	9.2
62.5	5.6	5.7 7.4	7.5 8.9	9.0 10.3	10.4
57.5	6.9	7.0 8.4	8.5 10.1	10.2 12.1	12.2
52.5	9.0	9.1 9.9	10.0 11.4	11.5 13.3	13.4
47.5	10.0	10.1 11.2	11.3 12.5	12.6 14.0	14.1
42.5	11.3	11.4 12.4	12.5 13.7	13.8 14.8	14.9
37.5	12.2	12.3 13.2	13.3 14.4	14.5 15.6	13.7
32.5	12.1	12.2 13.7	13.8 14.1	14.2 16.0	16.1
27.5	9.9	10.0 11.3	11.4 12.9	13.0 14.4	14.5
22.5	5.8	5.9 7.5	7.6 9.0	9.1 11.0	11.1
17.5	-0.1	0.0 2.5	2.6 4.2	4.3 5.8	5.9
12.5	-7.3	-7.2 -4.6	-4.5 -2.6	-2.5 -0.8	-0.7

Period 21-25 Month April Years 46, 47, 49, 50, 51

LAT.	MB	B	N	A	MA
67.5	4.1	4.2 5.5	5.6 7.2	7.3 8.6	8.7
62.5	5.1	5.2 6.5	6.6 8.2	8.3 10.0	10.1
57.5	6.2	6.3 7.6	7.7 9.6	9.7 11.6	11.7
52.5	8.0	8.1 9.4	9.5 11.1	11.2 13.1	13.2
47.5	9.9	10.0 11.0	11.1 12.2	12.3 13.4	13.5
42.5	11.1	11.2 12.2	12.3 13.5	13.6 14.5	14.6
37.5	12.0	12.1 12.9	13.0 14.3	14.4 15.3	15.4
32.5	11.8	11.9 13.4	13.5 14.7	14.8 15.6	15.7
27.5	9.6	9.7 10.8	10.9 12.2	12.3 13.4	13.5
22.5	5.4	5.5 6.9	7.0 8.3	8.4 10.2	10.3
17.5	-0.4	-0.3 2.1	2.2 3.6	3.7 5.2	5.3
12.5	-7.2	-7.1 -4.8	-4.7 -3.0	-2.9 -1.1	-1.0

Period 26-30 Month April Years 46, 47, 49, 50, 51

LAT.	MB	B	N	A	MA
67.5	4.0	4.1 5.4	5.5 6.6	6.7 8.5	8.6
62.5	4.7	4.8 5.9	6.0 7.4	7.5 9.3	9.4
57.5	5.8	5.9 7.1	7.2 9.1	9.2 11.0	11.1
52.5	7.9	8.0 8.9	9.0 10.7	10.8 12.7	12.8
47.5	9.7	9.8 10.8	10.9 12.0	12.1 13.4	13.5
42.5	11.0	11.1 12.1	12.2 13.3	13.4 14.3	14.4
37.5	11.9	12.0 12.8	12.9 14.1	14.2 15.2	15.3
32.5	11.6	11.7 13.1	13.2 14.4	14.5 15.2	15.3
27.5	9.3	9.4 10.7	10.8 11.9	12.0 13.2	13.3
22.5	5.1	5.2 6.4	6.5 7.6	7.7 9.4	9.5
17.5	-0.5	-0.4 1.7	1.8 3.1	3.2 4.8	4.9
12.5	-7.2	-7.1 -5.0	-4.9 -3.4	-3.3 -1.3	-1.2

TABLE V. (Continued)

CLASS LIMITS FOR HEMISPHERIC ZONAL WIND ANALYSIS
(meters per second)

Period 1-5 Month May Years 46,47,49,50,51

LAT.	MB	B		N		A		MA
67.5	3.3	3.4	4.7	4.8	5.8	6.0	8.0	8.1
62.5	4.2	4.3	5.3	5.4	6.7	6.8	8.3	8.4
57.5	5.2	5.3	6.4	6.5	8.2	8.3	10.3	10.4
52.5	7.5	7.6	8.4	8.5	10.2	10.3	12.1	12.2
47.5	9.6	9.7	10.5	10.6	11.6	11.7	12.9	13.0
42.5	10.7	10.8	11.8	11.9	13.1	13.2	14.1	14.2
37.5	11.6	11.7	12.6	12.7	13.8	13.9	14.9	15.0
32.5	11.3	11.4	12.7	12.8	13.9	14.0	14.7	14.8
27.5	8.9	9.0	10.2	10.3	11.3	11.4	12.5	12.6
22.5	4.7	4.8	5.8	5.9	7.0	7.1	8.6	8.7
17.5	-0.7	-0.6	1.1	1.2	2.6	2.7	4.2	4.3
12.5	-7.2	-7.1	-5.3	-5.2	-3.9	-3.8	-1.6	-1.5

Period 6-10 Month May Years 46,47,49,50,51

LAT.	MB	B		N		A		MA
67.5	2.9	3.0	4.1	4.2	5.4	5.5	7.4	7.5
62.5	3.7	3.8	4.7	4.8	6.0	6.1	7.5	7.6
57.5	4.6	4.7	5.9	6.0	7.3	7.4	9.4	9.5
52.5	7.2	7.3	8.0	8.1	9.6	9.7	11.5	11.6
47.5	9.4	9.5	10.3	10.4	11.3	11.4	12.6	12.7
42.5	10.6	10.7	11.6	11.7	12.8	12.9	13.8	13.9
37.5	11.4	11.5	12.4	12.5	13.6	13.7	14.7	14.8
32.5	10.9	11.0	12.2	12.3	13.4	13.5	14.2	14.3
27.5	8.4	8.5	9.6	9.7	10.7	10.8	11.9	12.0
22.5	4.1	4.2	5.2	5.3	6.2	6.3	7.9	8.0
17.5	-1.0	-0.9	0.6	0.7	2.0	2.1	3.8	3.9
12.5	-7.2	-7.1	-6.4	-6.3	-4.4	-4.3	-2.1	-2.0

Period 11-15 Month May Years 46,47,49,50,51

LAT.	MB	B		N		A		MA
67.5	2.6	2.7	3.7	3.8	5.1	5.2	6.9	7.0
62.5	3.3	3.4	4.3	4.4	5.4	5.5	7.0	7.1
57.5	4.3	4.4	5.5	5.6	6.6	6.7	8.3	8.4
52.5	6.9	7.0	7.8	7.9	9.2	9.3	11.0	11.1
47.5	9.3	9.4	10.1	10.2	11.0	11.1	12.3	12.4
42.5	10.4	10.5	11.5	11.6	12.6	12.7	13.6	13.7
37.5	11.1	11.2	12.2	12.3	13.4	13.5	14.5	14.6
32.5	10.5	10.6	11.7	11.8	12.9	13.0	13.8	13.9
27.5	7.7	7.8	8.9	9.0	10.2	10.3	11.3	11.4
22.5	3.6	3.7	4.5	4.6	5.4	5.5	7.2	7.3
17.5	-1.2	-1.1	0.1	0.2	1.5	1.6	2.8	2.9
12.5	-7.3	-7.2	-5.8	-5.7	-4.9	-4.8	-2.6	-2.5

Period 16-20 Month May Years 46,47,49,50,51

LAT.	MB	B		N		A		MA
67.5	2.3	2.4	3.5	3.6	4.8	4.9	6.5	6.6
62.5	2.9	3.0	4.1	4.2	5.1	5.2	6.8	6.9
57.5	4.0	4.1	5.4	5.5	6.4	6.5	8.1	8.2
52.5	6.7	6.8	7.8	7.9	9.0	9.1	10.7	10.8
47.5	9.1	9.2	10.0	10.1	10.9	11.0	12.1	12.2
42.5	10.1	10.2	11.3	11.4	12.3	12.4	13.4	13.5
37.5	10.8	10.9	12.0	12.1	13.1	13.2	14.3	14.4
32.5	10.1	10.2	11.1	11.2	12.4	12.5	13.2	13.3
27.5	6.5	6.6	8.0	8.1	9.5	9.6	10.5	10.6
22.5	2.7	2.8	3.5	3.6	4.8	4.9	6.4	6.5
17.5	-2.1	-2.0	-0.7	-0.6	1.0	1.1	2.2	2.3
12.5	-7.5	-7.4	-6.3	-6.2	-5.3	-5.2	-3.1	-3.0

Period 21-25 Month May Years 46,47,49,50,51

LAT.	MB	B		N		A		MA
67.5	2.2	2.3	3.4	3.5	4.7	4.8	6.3	6.4
62.5	2.7	2.8	3.9	4.0	5.0	5.1	6.6	6.7
57.5	3.8	3.9	5.3	5.4	6.8	6.9	8.1	8.2
52.5	6.6	6.7	7.8	7.9	9.1	9.2	10.7	10.8
47.5	9.0	9.1	9.9	10.0	10.8	10.9	12.0	12.1
42.5	9.9	10.0	11.0	11.1	12.1	12.2	13.2	13.3
37.5	10.4	10.5	11.6	11.7	12.6	12.7	13.9	14.0
32.5	9.5	9.6	10.3	10.4	11.6	11.7	12.6	12.7
27.5	5.3	5.4	6.7	6.8	8.5	8.6	9.8	9.9
22.5	1.7	1.8	2.4	2.5	4.0	4.1	5.7	5.8
17.5	-3.1	-3.0	-1.4	-1.3	0.5	0.6	1.7	1.8
12.5	-7.9	-7.8	-7.0	-6.9	-5.7	-5.6	-3.7	-3.6

Period 26-31 Month May Years 46,47,49,50,51

LAT.	MB	B		N		A		MA
67.5	2.2	2.3	3.4	3.5	4.6	4.7	6.1	6.2
62.5	2.6	2.7	3.8	3.9	4.9	5.0	6.6	6.7
57.5	3.8	3.9	5.3	5.4	6.5	6.6	8.2	8.3
52.5	6.5	6.6	7.9	8.0	9.1	9.2	10.6	10.7
47.5	8.8	8.9	9.9	10.0	10.8	10.9	12.0	12.1
42.5	9.7	9.8	10.9	11.0	11.9	12.0	13.1	13.2
37.5	10.1	10.2	11.2	11.3	12.2	12.3	13.7	13.8
32.5	9.1	9.2	9.9	10.0	11.0	11.1	12.0	12.1
27.5	5.7	5.8	6.0	6.1	8.0	8.1	9.3	9.4
22.5	1.0	1.1	1.8	1.9	3.5	3.6	5.2	5.3
17.5	-3.5	-3.4	-1.9	-1.8	0.0	0.1	1.4	1.5
12.5	-8.3	-8.2	-7.4	-7.3	-6.0	-5.9	-4.0	-3.9

TABLE V. (Continued)

CLASS LIMITS FOR HEMISPHERIC ZONAL WIND ANALYSIS

(meters per second)

Period 1-5 Month June Years 46, 47, 49, 50, 51

LAT.	MB	B		N		A		MA
67.5	2.3	2.4	3.4	3.5	4.5	4.6	6.0	6.1
62.5	2.4	2.5	3.6	3.7	4.8	4.9	6.6	6.7
57.5	3.6	3.7	5.3	5.4	6.7	6.8	8.3	8.4
52.5	6.4	6.5	7.9	8.0	9.3	9.4	10.6	10.7
47.5	8.6	8.7	9.9	10.0	10.8	10.9	11.9	12.0
42.5	9.4	9.5	10.6	10.7	11.6	11.7	12.8	12.9
37.5	9.5	9.6	10.6	10.7	11.6	11.7	13.1	13.2
32.5	8.1	8.2	8.9	9.0	10.0	10.1	11.1	11.2
27.5	3.6	3.7	4.8	4.9	6.8	6.9	8.5	8.6
22.5	-0.7	-0.6	0.8	0.9	2.6	2.7	4.5	4.6
17.5	-4.1	-4.0	-2.8	-2.7	-0.7	-0.6	0.9	1.0
12.5	-9.2	-9.1	-8.1	-8.0	-6.4	-6.3	-4.7	-4.6

Period 6-10 Month June Years 46, 47, 49, 50, 51

LAT.	MB	B		N		A		MA
67.5	2.3	2.4	3.4	3.5	4.5	4.6	5.8	5.9
62.5	2.3	2.4	3.6	3.7	4.8	4.9	6.5	6.6
57.5	3.6	3.7	5.4	5.5	6.8	6.9	8.4	8.5
52.5	6.4	6.5	8.0	8.1	9.3	9.4	10.7	10.8
47.5	8.5	8.6	9.9	10.0	10.8	10.9	11.9	12.0
42.5	9.2	9.3	10.4	10.5	11.5	11.6	12.7	12.8
37.5	9.0	9.1	10.2	10.3	11.2	11.3	12.6	12.7
32.5	7.4	7.5	8.1	8.2	9.2	9.3	10.5	10.6
27.5	2.9	3.0	4.1	4.2	6.1	6.2	8.8	8.9
22.5	-0.9	-0.8	0.1	0.2	2.1	2.2	3.8	3.9
17.5	-4.4	-4.3	-3.1	-3.0	-1.3	-1.2	0.5	0.6
12.5	-8.8	-8.7	-8.5	-8.4	-6.7	-6.6	-5.3	-5.2

Period 11-15 Month June Years 46, 47, 49, 50, 51

LAT.	MB	B		N		A		MA
67.5	2.4	2.5	3.5	3.6	4.5	4.6	5.7	5.8
62.5	2.2	2.3	3.4	3.5	4.7	4.8	6.5	6.6
57.5	3.5	3.6	5.4	5.5	6.9	7.0	8.5	8.6
52.5	6.3	6.4	8.1	8.2	9.4	9.5	10.8	10.9
47.5	8.4	8.5	9.9	10.0	10.9	11.0	11.9	12.0
42.5	9.1	9.2	10.1	10.2	11.3	11.4	12.5	12.6
37.5	8.4	8.5	9.6	9.7	10.7	10.8	11.8	11.9
32.5	6.1	6.2	7.1	7.2	8.2	8.3	9.6	9.7
27.5	2.8	2.9	3.1	3.2	5.2	5.3	6.7	6.8
22.5	-1.6	-1.5	-0.6	-0.5	1.1	1.2	2.9	3.0
17.5	-4.8	-4.7	-3.7	-3.6	-1.9	-1.8	-0.3	-0.2
12.5	-10.5	-10.4	-8.8	-8.7	-6.8	-6.7	-5.8	-5.7

Period 16-20 Month June Years 46, 47, 49, 50, 51

LAT.	MB	B		N		A		MA
67.5	2.4	2.5	3.5	3.6	4.5	4.6	5.7	5.8
62.5	2.2	2.3	3.4	3.5	4.7	4.8	6.5	6.6
57.5	3.6	3.7	5.4	5.5	7.0	7.1	8.5	8.6
52.5	6.5	6.6	8.3	8.4	9.6	9.7	10.9	11.0
47.5	8.5	8.6	10.0	10.1	11.0	11.1	12.0	12.1
42.5	9.0	9.1	9.9	10.0	11.1	11.2	12.3	12.4
37.5	8.1	8.2	9.1	9.2	10.3	10.4	11.3	11.4
32.5	5.2	5.3	6.2	6.3	7.5	7.6	8.8	8.9
27.5	1.3	1.4	2.3	2.4	4.6	4.7	5.9	6.0
22.5	-1.8	-1.7	-1.1	-1.0	0.4	0.5	2.2	2.3
17.5	-4.9	-4.8	-3.9	-3.8	-2.3	-2.2	-1.0	-0.9
12.5	-10.5	-10.4	-8.7	-8.6	-6.9	-6.8	-5.9	-5.8

Period 21-25 Month June Years 46, 47, 49, 50, 51

LAT.	MB	B		N		A		MA
67.5	2.4	2.5	3.5	3.6	4.4	4.5	5.7	5.8
62.5	2.1	2.2	3.5	3.6	4.8	4.9	6.5	6.6
57.5	3.7	3.8	5.5	5.6	7.0	7.1	8.5	8.6
52.5	7.1	7.2	8.5	8.6	9.8	9.9	11.2	11.3
47.5	8.7	8.8	10.1	10.2	11.2	11.3	12.1	12.2
42.5	8.9	9.0	9.8	9.9	11.0	11.1	12.2	12.3
37.5	7.6	7.7	8.6	8.7	9.9	10.0	10.7	10.8
32.5	4.2	4.3	5.4	5.5	6.7	6.8	8.0	8.1
27.5	0.7	0.8	1.8	1.9	4.1	4.2	5.1	5.2
22.5	-2.0	-1.9	-1.4	-1.3	-0.1	0.0	1.3	1.4
17.5	-4.9	-4.8	-4.1	-4.0	-2.6	-2.5	-1.5	-1.4
12.5	-10.1	-10.0	-8.5	-8.4	-6.8	-6.7	-5.8	-5.7

Period 26-30 Month June Years 46, 47, 49, 50, 51

LAT.	MB	B		N		A		MA
67.5	2.2	2.3	3.4	3.5	4.6	4.7	5.7	5.8
62.5	2.1	2.2	3.5	3.6	4.8	4.9	6.5	6.6
57.5	3.9	4.0	5.6	5.7	6.9	7.0	8.5	8.6
52.5	7.4	7.5	8.6	8.7	9.9	10.0	11.4	11.5
47.5	9.0	9.1	10.4	10.5	11.4	11.5	12.3	12.4
42.5	8.8	8.9	9.4	9.5	10.8	10.9	11.8	11.9
37.5	7.1	7.2	8.1	8.2	9.4	9.5	10.3	10.4
32.5	3.3	3.4	4.6	4.7	6.1	6.2	7.4	7.5
27.5	0.1	0.2	1.3	1.4	3.3	3.4	4.2	4.3
22.5	-2.2	-2.1	-1.5	-1.4	-0.4	-0.3	0.6	0.7
17.5	-4.9	-4.8	-4.2	-4.1	-2.9	-2.8	-1.9	-1.8
12.5	-9.8	-9.7	-8.2	-8.1	-6.6	-6.5	-5.5	-5.4

TABLE V. (Continued)

CLASS LIMITS FOR HEMISPHERIC ZONAL WIND ANALYSIS

(meters per second)

Period 1-5 Month July Years 46,47,49,50,51

LAT.	MB	B		N		A		MA
67.5	1.8	1.9	3.3	3.4	4.6	4.7	5.8	5.9
62.5	2.1	2.2	3.6	3.7	4.9	5.0	6.4	6.5
57.5	4.0	4.1	5.7	5.8	7.1	7.2	8.4	8.5
52.5	7.8	7.9	8.8	8.9	10.1	10.2	11.6	11.7
47.5	9.3	9.4	10.8	10.9	11.6	11.7	12.6	12.7
42.5	8.8	8.9	9.7	9.8	10.7	10.8	11.8	11.9
37.5	6.4	6.5	7.5	7.6	8.8	8.9	9.7	9.8
32.5	2.6	2.7	3.9	4.0	5.0	5.1	6.4	6.5
27.5	-0.6	-0.5	0.6	0.7	2.3	2.4	3.3	3.4
22.5	-2.4	-2.3	-1.8	-1.7	-0.8	-0.7	-0.1	0.0
17.5	-4.9	-4.8	-4.3	-4.2	-3.2	-3.1	-2.4	-2.3
12.5	-9.3	-9.2	-7.9	-7.8	-6.3	-6.2	-5.1	-5.0

Period 6-10 Month July Years 46,47,49,50,51

LAT.	MB	B		N		A		MA
67.5	1.5	1.6	3.1	3.2	4.7	4.8	5.8	5.9
62.5	2.1	2.2	3.7	3.8	4.9	5.0	6.4	6.5
57.5	4.2	4.3	5.8	5.9	7.2	7.3	8.4	8.5
52.5	8.0	8.1	9.1	9.2	10.2	10.3	11.7	11.8
47.5	9.5	9.6	11.0	11.1	11.8	11.9	12.7	12.8
42.5	8.7	8.8	9.6	9.7	10.6	10.7	11.6	11.7
37.5	5.8	5.9	6.9	7.0	8.2	8.3	9.2	9.3
32.5	2.0	2.1	3.2	3.3	4.2	4.3	5.5	5.6
27.5	-1.0	-0.9	0.0	0.1	1.3	1.4	2.5	2.6
22.5	-2.6	-2.5	-2.0	-1.9	-1.2	-1.1	-0.6	-0.5
17.5	-4.9	-4.8	-4.4	-4.3	-3.5	-3.4	-2.8	-2.7
12.5	-9.0	-8.9	-7.6	-7.5	-6.2	-6.1	-4.8	-4.7

Period 11-15 Month July Years 46,47,49,50,51

LAT.	MB	B		N		A		MA
67.5	1.3	1.4	3.1	3.2	4.8	4.9	5.9	6.0
62.5	2.1	2.2	3.8	3.9	4.9	5.0	6.3	6.4
57.5	4.4	4.5	5.9	6.0	7.2	7.3	8.4	8.5
52.5	8.1	8.2	9.2	9.3	10.3	10.4	11.8	11.9
47.5	9.6	9.7	11.1	11.2	11.9	12.0	12.8	12.9
42.5	8.6	8.7	9.5	9.6	10.5	10.6	11.4	11.5
37.5	5.6	5.7	6.5	6.6	7.8	7.9	8.8	8.9
32.5	1.5	1.6	2.6	2.7	3.8	3.9	5.0	5.1
27.5	-1.3	-1.2	-0.4	-0.3	0.8	0.9	1.8	1.9
22.5	-2.7	-2.6	-2.1	-2.0	-1.4	-1.3	-0.8	-0.7
17.5	-4.9	-4.8	-4.4	-4.3	-3.7	-3.6	-3.0	-2.9
12.5	-8.8	-8.7	-7.3	-7.2	-6.1	-6.0	-4.7	-4.6

Period 16-20 Month July Years 46,47,49,50,51

LAT.	MB	B		N		A		MA
67.5	1.3	1.4	3.1	3.2	4.9	5.0	6.0	6.1
62.5	2.1	2.2	3.8	3.9	4.9	5.0	6.3	6.4
57.5	4.6	4.7	5.9	6.0	7.2	7.3	8.4	8.5
52.5	8.3	8.4	9.3	9.4	10.3	10.4	11.8	11.9
47.5	9.7	9.8	11.1	11.2	11.9	12.0	12.9	13.0
42.5	8.6	8.7	9.4	9.5	10.4	10.5	11.4	11.5
37.5	5.4	5.5	6.3	6.4	7.4	7.5	8.5	8.6
32.5	1.4	1.5	2.3	2.4	3.5	3.6	4.5	4.6
27.5	-1.6	-1.5	-0.7	-0.6	0.3	0.4	1.4	1.5
22.5	-2.9	-2.8	-2.3	-2.2	-1.6	-1.5	-1.0	-0.9
17.5	-5.0	-4.9	-4.5	-4.4	-3.8	-3.7	-3.2	-3.1
12.5	-8.7	-8.6	-7.3	-7.2	-6.2	-6.1	-4.9	-4.8

Period 21-25 Month July Years 46,47,49,50,51

LAT.	MB	B		N		A		MA
67.5	1.3	1.4	3.2	3.3	5.0	5.1	6.2	6.3
62.5	2.3	2.4	3.9	4.0	4.8	4.9	6.2	6.3
57.5	4.7	4.8	5.9	6.0	7.2	7.3	8.4	8.5
52.5	8.2	8.3	9.3	9.4	10.3	10.4	11.5	11.6
47.5	9.6	9.7	10.9	11.0	11.8	11.9	12.9	13.0
42.5	8.4	8.5	9.4	9.5	10.3	10.4	11.3	11.4
37.5	5.3	5.4	6.2	6.3	7.2	7.3	8.4	8.5
32.5	1.4	1.5	2.3	2.4	3.4	3.5	4.4	4.5
27.5	-1.6	-1.5	-0.8	-0.7	0.2	0.3	1.2	1.3
22.5	-3.1	-3.0	-2.5	-2.4	-1.8	-1.7	-1.0	-0.9
17.5	-5.1	-5.0	-4.5	-4.4	-3.8	-3.7	-3.2	-3.1
12.5	-8.7	-8.6	-7.5	-7.4	-6.3	-6.2	-5.3	-5.2

Period 26-31 Month July Years 46,47,49,50,51

LAT.	MB	B		N		A		MA
67.5	1.5	1.6	3.4	3.5	5.1	5.2	6.3	6.4
62.5	2.4	2.5	3.9	4.0	4.8	4.9	6.1	6.2
57.5	4.7	4.8	5.9	6.0	7.2	7.3	8.5	8.6
52.5	8.3	8.3	9.3	9.4	10.2	10.3	11.3	11.4
47.5	9.6	9.7	10.8	10.9	11.6	11.7	12.8	12.9
42.5	8.3	8.4	9.4	9.5	10.3	10.4	11.2	11.3
37.5	5.3	5.4	6.2	6.3	7.2	7.3	8.3	8.4
32.5	1.4	1.5	2.2	2.3	3.3	3.4	4.5	4.6
27.5	-1.6	-1.5	-0.8	-0.7	0.1	0.2	1.1	1.2
22.5	-3.3	-3.2	-2.6	-2.5	-1.8	-1.7	-1.1	-1.0
17.5	-5.2	-5.1	-4.5	-4.4	-3.8	-3.7	-3.2	-3.1
12.5	-8.9	-8.8	-7.6	-7.5	-6.8	-6.7	-5.6	-5.5

TABLE V. (Continued)

CLASS LIMITS FOR HEMISPHERIC ZONAL WIND ANALYSIS

(meters per second)

Period 1-5 Month August Years 48, 47, 49, 50, 51

LAT.	MB	B		N		A		MA
67.5	1.8	1.9	3.6	3.7	5.2	5.3	6.5	6.6
62.5	2.6	2.7	4.0	4.1	4.8	4.9	6.0	6.1
57.5	4.8	4.9	5.8	5.9	7.1	7.2	8.6	8.7
52.5	8.2	8.3	9.3	9.4	10.2	10.3	11.1	11.2
47.5	9.5	9.6	10.7	10.8	11.7	11.8	12.8	12.9
42.5	8.0	8.1	9.2	9.3	10.3	10.4	11.1	11.2
37.5	5.4	5.5	6.3	6.4	7.2	7.3	8.2	8.3
32.5	1.4	1.5	2.3	2.4	3.2	3.3	4.3	4.4
27.5	-1.6	-1.5	-0.8	-0.7	0.0	0.1	1.1	1.2
22.5	-3.6	-3.5	-2.7	-2.6	-2.0	-1.9	-1.2	-1.1
17.5	-5.4	-5.3	-4.6	-4.5	-3.8	-3.7	-3.2	-3.1
12.5	-9.1	-9.0	-7.9	-7.8	-6.9	-6.8	-6.1	-6.0

Period 6-10 Month August Years 48, 47, 49, 50, 51

LAT.	MB	B		N		A		MA
67.5	2.1	2.2	3.9	4.0	5.4	5.5	6.7	6.8
62.5	2.8	2.9	4.0	4.1	4.7	4.8	5.9	6.0
57.5	4.9	5.0	5.8	5.9	7.1	7.2	8.6	8.7
52.5	8.2	8.3	9.2	9.3	10.1	10.2	10.9	11.0
47.5	9.5	9.6	10.7	10.8	11.7	11.8	12.7	12.8
42.5	8.2	8.3	9.4	9.5	10.3	10.4	11.2	11.3
37.5	5.4	5.5	6.4	6.5	7.2	7.3	8.3	8.4
32.5	1.5	1.6	2.3	2.4	3.2	3.3	4.3	4.4
27.5	-1.5	-1.4	-0.7	-0.6	0.1	0.2	1.1	1.2
22.5	-3.7	-3.6	-2.7	-2.6	-2.1	-2.0	-1.2	-1.1
17.5	-5.5	-5.4	-4.6	-4.5	-3.8	-3.7	-3.2	-3.1
12.5	-9.2	-9.1	-8.1	-8.0	-7.2	-7.1	-6.3	-6.2

Period 11-15 Month August Years 48, 47, 49, 50, 51

LAT.	MB	B		N		A		MA
67.5	2.5	2.6	4.2	4.3	5.5	5.6	6.9	7.0
62.5	3.0	3.1	4.1	4.2	4.8	4.9	5.9	6.0
57.5	5.0	5.1	5.8	5.9	7.1	7.2	8.7	8.8
52.5	8.2	8.3	9.2	9.3	10.0	10.1	10.8	10.9
47.5	9.4	9.5	10.6	10.7	11.6	11.7	12.7	12.8
42.5	8.2	8.3	9.5	9.6	10.4	10.5	11.6	11.7
37.5	5.6	5.7	6.5	6.6	7.4	7.5	8.4	8.5
32.5	1.7	1.8	2.4	2.5	3.3	3.4	4.3	4.4
27.5	-1.4	-1.3	-0.6	-0.5	0.2	0.3	1.1	1.2
22.5	-3.8	-3.7	-2.7	-2.6	-2.1	-2.0	-1.2	-1.1
17.5	-5.7	-5.6	-4.7	-4.6	-3.8	-3.7	-3.2	-3.1
12.5	-9.3	-9.2	-8.3	-8.2	-7.4	-7.3	-6.4	-6.3

Period 16-20 Month August Years 48, 47, 49, 50, 51

LAT.	MB	B		N		A		MA
67.5	2.8	2.9	4.4	4.5	5.5	5.6	7.0	7.1
62.5	3.0	3.1	4.2	4.3	4.9	5.0	6.0	6.1
57.5	5.0	5.1	6.0	6.1	7.2	7.3	8.9	9.0
52.5	8.2	8.3	9.2	9.3	10.0	10.1	11.0	11.1
47.5	9.4	9.5	10.7	10.8	11.7	11.8	12.8	12.9
42.5	8.0	8.1	9.6	9.7	10.5	10.6	11.4	11.5
37.5	5.8	5.9	6.8	6.9	7.9	8.0	8.8	8.9
32.5	2.0	2.1	2.7	2.8	3.6	3.7	4.5	4.6
27.5	-1.2	-1.1	-0.4	-0.3	0.5	0.6	1.4	1.5
22.5	-3.7	-3.6	-2.7	-2.6	-2.1	-2.0	-1.2	-1.1
17.5	-5.4	-5.3	-4.9	-4.8	-3.9	-3.8	-3.2	-3.1
12.5	-9.2	-9.1	-8.3	-8.2	-7.4	-7.3	-6.3	-6.2

Period 21-25 Month August Years 46, 47, 49, 50, 51

LAT.	MB	B		N		A		MA
67.5	2.7	2.8	4.5	4.6	5.5	5.6	7.1	7.2
62.5	3.0	3.1	4.2	4.3	5.1	5.2	6.1	6.2
57.5	5.0	5.1	6.1	6.2	7.4	7.5	9.2	9.3
52.5	8.1	8.2	9.3	9.4	10.2	10.3	11.3	11.4
47.5	9.5	9.6	10.8	10.9	11.7	11.8	12.9	13.0
42.5	8.7	8.8	9.8	9.9	10.7	10.8	11.6	11.7
37.5	6.2	6.3	7.2	7.3	8.5	8.6	9.5	9.6
32.5	2.3	2.4	3.2	3.3	4.0	4.1	5.1	5.2
27.5	-1.1	-1.0	-0.1	0.0	0.5	0.6	1.6	1.7
22.5	-3.6	-3.5	-2.6	-2.5	-1.9	-1.8	-1.2	-1.1
17.5	-6.0	-5.9	-4.8	-4.7	-4.0	-3.9	-3.2	-3.1
12.5	-9.2	-9.1	-8.2	-8.1	-7.3	-7.2	-6.2	-6.1

Period 26-31 Month August Years 46, 47, 49, 50, 51

LAT.	MB	B		N		A		MA
67.5	2.7	2.8	4.5	4.6	5.5	5.6	7.1	7.2
62.5	3.1	3.2	4.3	4.4	5.2	5.3	6.3	6.4
57.5	5.0	5.1	6.3	6.4	7.6	7.7	9.4	9.5
52.5	8.1	8.2	9.4	9.5	10.6	10.7	12.0	12.1
47.5	9.6	9.7	11.0	11.1	11.9	12.0	13.1	13.2
42.5	9.0	9.1	10.1	10.2	11.0	11.1	12.1	12.2
37.5	5.5	5.6	7.7	7.8	9.1	9.2	10.2	10.3
32.5	2.6	2.7	3.6	3.7	4.4	4.5	5.9	6.0
27.5	-0.9	-0.8	0.1	0.2	1.2	1.3	2.1	2.2
22.5	-3.4	-3.3	-2.5	-2.4	-1.7	-1.6	-1.0	-0.9
17.5	-6.1	-6.0	-4.9	-4.8	-4.1	-4.0	-3.1	-3.0
12.5	-9.1	-9.0	-8.1	-8.0	-7.1	-7.0	-6.0	-5.9

TABLE V. (Continued)

CLASS LIMITS FOR HEMISPHERIC ZONAL WIND ANALYSIS

(meters per second)

Period 1-5 Month September Years 46,47,49,50,51

LAT.	MB	B	B	N	N	A	A	MA
67.5	2.8	3.7	4.4	4.5	5.5	5.6	7.1	7.2
62.5	3.1	3.2	4.5	4.6	5.4	5.5	6.8	6.9
57.5	5.0	5.1	6.7	6.8	7.9	8.0	9.7	9.8
52.5	8.0	8.1	9.5	9.6	10.9	11.0	12.6	12.7
47.5	9.8	9.9	11.3	11.4	12.3	12.4	13.5	13.6
42.5	9.5	9.6	10.6	10.7	11.4	11.5	12.7	12.8
37.5	7.0	7.1	8.4	8.5	9.7	9.8	11.1	11.2
32.5	3.0	3.1	4.2	4.3	5.3	5.4	6.9	7.0
27.5	-0.6	-0.5	0.5	0.6	1.8	1.9	2.7	2.8
22.5	-3.1	-3.0	-2.2	-2.1	-1.4	-1.3	-0.7	-0.6
17.5	-6.1	-6.0	-5.0	-4.9	-4.2	-4.1	-3.1	-3.0
12.5	-9.0	-8.9	-7.9	-7.8	-6.8	-6.7	-5.8	-5.7

Period 6-10 Month September Years 46,47,49,50,51

LAT.	MB	B	B	N	N	A	A	MA
67.5	2.5	2.6	4.4	4.5	5.5	5.6	7.1	7.2
62.5	3.2	3.3	4.6	4.7	5.6	5.7	7.2	7.3
57.5	5.0	5.1	7.0	7.1	8.3	8.4	9.9	10.0
52.5	8.0	8.1	9.7	9.8	11.3	11.4	13.2	13.3
47.5	9.9	10.0	11.6	11.7	12.8	12.9	13.9	14.0
42.5	10.0	10.1	11.0	11.1	11.9	12.0	13.2	13.3
37.5	7.5	7.6	9.0	9.1	10.3	10.4	11.8	11.9
32.5	3.4	3.5	4.8	4.9	6.0	6.1	7.9	8.0
27.5	-0.2	-0.1	1.0	1.1	2.3	2.4	3.0	3.1
22.5	-2.9	-2.8	-1.9	-1.8	-1.0	-0.9	-0.4	-0.3
17.5	-6.1	-6.0	-5.0	-4.9	-4.3	-4.2	-2.5	-2.4
12.5	-8.9	-8.8	-7.7	-7.6	-6.6	-6.5	-5.6	-5.5

Period 11-15 Month September Years 46,47,49,50,51

LAT.	MB	B	B	N	N	A	A	MA
67.5	2.5	2.6	4.3	4.4	5.4	5.5	7.2	7.3
62.5	3.3	3.4	4.7	4.8	5.8	5.9	7.5	7.6
57.5	5.0	5.1	7.3	7.4	8.6	8.7	10.2	10.3
52.5	8.0	8.1	9.9	10.0	11.7	11.8	13.6	13.7
47.5	10.0	10.1	11.9	12.0	13.2	13.3	14.3	14.4
42.5	10.3	10.4	11.4	11.5	12.4	12.5	13.7	13.8
37.5	8.0	8.1	9.6	9.7	10.8	10.9	12.2	12.3
32.5	3.9	4.0	5.5	5.6	6.7	6.8	8.5	8.5
27.5	0.1	0.2	1.4	1.5	2.7	2.8	3.5	3.6
22.5	-2.6	-2.5	-1.6	-1.5	-0.7	-0.6	0.0	0.1
17.5	-6.1	-6.0	-5.0	-4.9	-4.2	-4.1	-2.9	-2.8
12.5	-8.8	-8.7	-7.6	-7.5	-6.5	-6.4	-5.4	-5.3

Period 16-20 Month September Years 46,47,49,50,51

LAT.	MB	B	B	N	N	A	A	MA
67.5	2.6	2.7	4.4	4.5	5.5	5.6	7.3	7.4
62.5	3.6	3.7	4.9	5.0	6.1	6.2	7.8	7.9
57.5	5.0	5.1	7.6	7.7	9.0	9.1	10.4	10.5
52.5	8.1	8.2	10.1	10.2	12.1	12.2	13.9	14.0
47.5	10.4	10.5	12.3	12.4	13.7	13.8	14.8	14.9
42.5	10.7	10.8	11.8	11.9	12.8	12.9	14.1	14.2
37.5	8.5	8.6	10.1	10.2	11.3	11.4	12.7	12.8
32.5	4.3	4.4	5.9	6.0	7.2	7.3	9.0	9.1
27.5	0.5	0.6	2.7	2.8	3.1	3.2	3.9	4.0
22.5	-2.3	-2.2	-1.2	-1.1	-0.4	-0.3	0.3	0.4
17.5	-5.9	-5.8	-4.9	-4.8	-4.0	-3.9	-2.7	-2.6
12.5	-8.7	-8.6	-7.4	-7.3	-6.3	-6.2	-5.2	-5.1

Period 21-25 Month September Years 46,47,49,50,51

LAT.	MB	B	B	N	N	A	A	MA
67.5	2.9	3.0	4.6	4.7	5.5	5.6	7.5	7.6
62.5	3.9	4.0	5.2	5.3	6.4	6.5	8.0	8.1
57.5	5.3	5.4	7.8	7.9	9.2	9.3	10.7	10.8
52.5	8.6	8.7	10.6	10.7	12.4	12.5	14.3	14.4
47.5	11.0	11.1	12.7	12.8	14.3	14.4	15.4	15.5
42.5	11.1	11.2	12.2	12.3	13.4	13.5	14.6	14.7
37.5	9.0	9.1	10.5	10.6	11.7	11.8	13.0	13.1
32.5	4.9	5.0	6.5	6.6	7.9	8.0	9.7	9.8
27.5	1.2	1.3	2.4	2.5	3.7	3.8	4.6	4.7
22.5	-2.0	-1.9	-0.9	-0.8	-0.1	0.0	0.8	0.9
17.5	-5.6	-5.5	-4.6	-4.5	-3.4	-3.3	-2.3	-2.2
12.5	-8.5	-8.4	-7.3	-7.2	-6.1	-6.0	-5.0	-4.9

Period 26-30 Month September Years 46,47,49,50,51

LAT.	MB	B	B	N	N	A	A	MA
67.5	3.3	3.4	4.7	4.8	5.6	5.7	7.7	7.8
62.5	4.3	4.4	5.4	5.5	6.7	6.8	8.2	8.3
57.5	5.9	6.0	8.0	8.1	9.4	9.5	10.8	10.9
52.5	9.2	9.3	11.0	11.1	12.7	12.8	14.6	14.7
47.5	11.6	11.7	13.1	13.2	14.7	14.8	16.0	16.1
42.5	11.4	11.5	12.5	12.6	13.7	13.8	15.0	15.1
37.5	9.3	9.4	10.9	11.0	12.1	12.2	13.4	13.5
32.5	5.5	5.6	6.9	7.0	8.5	8.6	10.3	10.4
27.5	1.7	1.8	2.9	3.0	4.2	4.3	5.1	5.2
22.5	-1.6	-1.5	-0.5	-0.4	0.2	0.3	1.2	1.3
17.5	-5.3	-5.2	-4.2	-4.1	-3.0	-2.9	-2.0	-1.9
12.5	-8.3	-8.2	-7.1	-7.0	-6.0	-5.9	-4.9	-4.8

TABLE V. (Continued)

CLASS LIMITS FOR HEMISPHERIC ZONAL WIND ANALYSIS
(meters per second)

Period 1-5 Month October Years 45, 46, 47, 49, 50, 51

LAT.	MB	B		N		A		MA
67.5	5.9	4.0	5.1	5.2	6.0	6.1	8.1	8.2
62.5	4.9	5.0	5.7	5.8	7.0	7.1	8.5	8.6
57.5	6.6	6.7	8.3	8.4	9.7	9.8	11.0	11.1
52.5	10.0	10.1	11.6	11.7	13.0	13.1	14.9	15.0
47.5	12.2	12.3	13.5	13.6	[illegible]	15.3	16.7	16.8
42.5	11.9	[illegible]	13.1	13.2	14.3	14.4	15.5	15.6
37.5	10.1	10.2	11.4	11.5	12.7	12.8	13.8	13.9
32.5	6.2	6.3	7.7	7.8	9.4	9.5	11.1	11.2
27.5	2.6	2.7	3.7	3.8	4.9	5.0	6.0	6.1
22.5	-1.1	-1.0	0.1	0.2	1.0	1.1	1.9	2.0
17.5	-4.8	-4.7	-3.7	-3.6	-2.5	-2.4	-1.4	-1.3
12.5	-8.2	-8.1	-6.9	-6.8	-5.8	-5.7	-4.7	-4.6

Period 6-10 Month October Years 45, 46, 47, 49, 50, 51

LAT.	MB	B		N		A		MA
67.5	4.5	4.6	5.4	5.5	6.4	6.5	8.4	8.5
62.5	5.3	5.3	6.1	6.3	7.2	7.3	8.7	8.8
57.5	7.1	7.2	8.5	8.6	9.8	9.9	11.2	11.3
52.5	10.4	10.5	11.9	13.0	13.3	13.4	15.0	15.1
47.5	12.6	12.7	13.6	14.0	15.4	15.5	17.0	17.1
42.5	12.2	12.3	13.5	13.6	14.8	14.9	15.9	16.0
37.5	10.8	10.9	12.1	12.3	13.4	13.5	14.6	14.7
32.5	7.0	7.1	8.5	8.6	10.1	10.2	11.7	11.8
27.5	3.4	3.5	4.5	4.6	5.6	5.7	6.9	7.0
22.5	-0.3	-0.2	0.7	0.8	1.6	1.7	2.5	2.6
17.5	-4.4	-4.3	-3.3	-3.2	-2.0	-1.9	-0.8	-0.7
12.5	-8.1	-8.0	-6.7	-6.6	-5.6	-5.5	-4.4	-4.3

Period 11-15 Month October Years 45, 46, 47, 49, 50, 51

LAT.	MB	B		N		A		MA
67.5	4.7	4.8	5.7	5.8	7.0	7.1	8.6	8.7
62.5	5.3	5.4	6.3	6.4	7.4	7.5	8.8	8.9
57.5	7.3	7.4	8.7	8.8	10.0	10.1	11.3	11.4
52.5	10.6	10.7	12.1	12.2	13.5	13.6	15.2	15.3
47.5	13.9	13.0	14.2	14.3	16.6	16.7	17.2	17.3
42.5	12.5	12.6	13.8	13.9	15.3	15.3	16.4	16.5
37.5	11.0	11.1	12.3	12.4	13.5	13.6	14.7	14.8
32.5	7.7	7.8	9.2	9.3	10.9	11.0	12.4	12.5
27.5	4.2	4.3	5.2	5.3	6.3	6.4	7.6	7.7
22.5	0.3	0.4	1.2	1.3	2.1	3.2	3.0	3.1
17.5	-4.0	-3.9	-2.9	-2.8	-1.6	-1.5	-0.5	-0.4
12.5	-8.0	-7.9	-6.6	-6.5	-5.5	-5.4	-4.2	-4.1

Period 16-20 Month October Years 45, 46, 47, 49, 50, 51

LAT.	MB	B		N		A		MA
67.5	4.6	4.7	5.9	6.0	7.2	7.3	8.6	8.7
62.5	5.2	5.3	6.2	6.3	7.5	7.6	8.9	9.0
57.5	7.2	7.3	8.7	8.8	10.0	10.1	11.4	11.5
52.5	10.7	10.8	12.3	13.4	13.7	13.8	15.2	15.3
47.5	13.1	13.2	14.4	14.5	15.9	16.0	17.3	17.4
42.5	12.7	12.8	14.3	14.3	15.6	15.7	16.8	16.9
37.5	11.5	11.6	12.9	13.0	14.0	14.1	15.3	15.4
32.5	8.5	8.6	10.1	10.2	11.7	11.8	13.1	13.2
27.5	5.2	5.3	6.1	6.2	7.3	7.3	8.7	8.8
22.5	1.0	1.1	1.9	2.0	3.0	3.1	3.8	3.9
17.5	-3.5	-3.4	-2.4	-2.3	-1.2	-1.1	0.0	0.1
12.5	-7.9	-7.8	-6.4	-6.3	-5.2	-5.1	-4.0	-3.9

Period 21-25 Month October Years 45, 46, 47, 49, 50, 51

LAT.	MB	B		N		A		MA
67.5	4.5	4.6	5.6	5.9	7.1	7.2	8.5	8.6
62.5	4.7	4.8	6.0	6.1	7.5	7.8	8.9	9.0
57.5	7.0	7.1	8.5	8.6	10.0	10.1	11.5	11.6
52.5	10.8	10.9	13.3	13.4	13.7	13.6	15.3	15.4
47.5	13.2	13.3	14.5	14.6	16.1	16.2	17.4	17.5
42.5	12.9	13.0	14.5	14.6	16.0	16.1	17.2	17.3
37.5	11.9	13.0	13.4	13.5	14.7	14.8	16.0	16.1
32.5	9.3	9.3	11.1	11.2	12.6	12.7	14.0	14.1
27.5	6.0	6.1	7.0	7.1	8.1	8.3	9.7	9.8
22.5	1.7	1.8	3.7	2.8	3.8	3.9	4.6	4.7
17.5	-3.1	-3.0	-2.0	-1.9	-0.7	-0.6	0.6	0.7
12.5	-7.7	-7.6	-6.3	-6.1	-5.0	-4.9	-3.8	-3.7

Period 26-31 Month October Years 45, 46, 47, 49, 50, 51

LAT.	MB	B		N		A		MA
67.5	4.1	4.2	5.6	5.7	6.9	7.0	8.4	8.5
62.5	4.3	4.4	5.9	6.0	7.4	7.5	8.9	9.0
57.5	6.8	6.9	8.4	8.5	9.9	10.0	11.5	11.6
52.5	10.7	10.8	12.3	12.4	13.8	13.9	15.3	15.4
47.5	13.2	13.3	14.5	14.6	16.1	16.2	17.4	17.5
42.5	13.2	13.3	14.7	14.8	16.4	16.5	17.5	17.6
37.5	12.3	12.4	13.8	13.9	15.4	15.5	16.5	16.6
32.5	9.9	10.0	11.8	11.9	13.2	13.3	14.5	14.6
27.5	6.7	6.8	7.8	7.9	9.0	9.1	9.6	9.7
22.5	2.3	2.4	3.4	3.5	4.4	4.5	5.5	5.6
17.5	-3.0	-2.9	-1.5	-1.4	-0.2	-0.1	0.9	1.0
12.5	-7.7	-7.6	-6.0	-5.9	-4.8	-4.7	-3.6	-3.5

TABLE V. (Continued)

CLASS LIMITS FOR HEMISPHERIC ZONAL WIND ANALYSIS

(meters per second)

Period 1-5 Month November Years 45,46,47,49,50,51

LAT.	MB	B	N	A	MA
67.5	3.5	3.6 5.2	5.3 5.6	6.7 8.1	8.2
62.5	3.7	3.8 5.6	5.7 7.3	7.4 8.9	9.0
57.5	6.6	6.7 8.3	8.4 9.8	9.9 11.6	11.7
52.5	10.7	10.8 12.3	12.4 13.8	13.9 15.2	15.3
47.5	12.7	12.8 14.6	14.7 16.2	16.3 17.5	17.6
42.5	13.4	13.5 15.0	15.1 16.6	16.7 17.8	17.9
37.5	12.8	12.9 14.3	14.4 16.0	16.1 17.1	17.2
32.5	10.7	10.8 12.7	12.8 14.1	14.2 15.5	15.6
27.5	7.5	7.6 8.9	9.0 9.9	10.0 11.7	11.8
22.5	3.1	3.2 4.1	4.2 5.2	5.3 6.4	6.5
17.5	-2.3	-2.2 -1.0	-0.9 0.3	0.4 1.4	1.5
12.5	-7.6	-7.5 -5.8	-5.7 -4.5	-4.4 -3.3	-3.2

Period 6-10 Month November Years 45,46,47,49,50,51

LAT.	MB	B	N	A	MA
67.5	2.9	3.0 4.8	4.9 6.3	6.4 7.8	7.9
62.5	3.3	3.4 5.4	5.5 7.3	7.4 8.9	9.0
57.5	6.3	6.4 8.2	8.3 9.8	9.9 11.6	11.7
52.5	11.1	11.2 12.2	12.3 13.8	13.9 15.2	15.3
47.5	13.2	13.3 14.6	14.7 16.3	16.4 17.5	17.6
42.5	13.7	13.8 15.2	15.3 16.9	17.0 18.1	18.2
37.5	13.2	13.3 14.8	14.9 16.5	16.6 17.7	17.8
32.5	11.4	11.5 13.4	13.5 14.7	14.8 16.1	16.2
27.5	8.3	8.4 9.7	9.8 10.8	10.9 12.5	12.6
22.5	3.6	3.7 4.8	4.9 6.0	6.1 7.1	7.2
17.5	-1.9	-1.8 -0.5	-0.4 0.8	0.9 1.8	1.9
12.5	-7.4	-7.3 -5.6	-5.5 -4.1	-4.0 -3.0	-2.9

Period 11-15 Month November Years 45,46,47,49,50,51

LAT.	MB	B	N	A	MA
67.5	2.0	2.1 3.9	4.0 5.9	6.0 7.5	7.6
62.5	2.5	2.6 5.1	5.2 7.2	7.3 8.8	8.9
57.5	5.9	6.0 8.0	8.1 9.6	9.7 11.6	11.7
52.5	10.5	10.6 12.1	12.2 13.7	13.8 15.2	15.3
47.5	13.2	13.3 14.6	14.7 16.3	16.4 17.5	17.6
42.5	14.0	14.1 15.4	15.5 17.2	17.3 18.5	18.6
37.5	13.8	13.9 15.5	15.6 17.3	17.4 18.5	18.6
32.5	12.2	12.3 14.5	14.6 15.7	15.8 16.9	17.0
27.5	9.4	9.5 10.7	10.8 11.8	11.9 13.4	13.5
22.5	4.4	4.5 5.8	5.9 6.9	7.0 7.9	8.0
17.5	-1.3	-1.2 0.0	0.1 1.3	1.4 2.4	2.5
12.5	-7.2	-7.1 -5.4	-5.3 -3.9	-3.8 -2.7	-2.6

Period 16-20 Month November Years 45,46,47,49,50,51

LAT.	MB	B	N	A	MA
67.5	1.7	1.8 3.6	3.7 5.8	5.9 7.3	7.4
62.5	2.3	2.4 4.9	5.0 7.2	7.3 8.8	8.9
57.5	5.6	5.7 7.8	7.9 9.6	9.7 11.6	11.7
52.5	10.4	10.5 12.0	12.1 13.7	13.8 15.2	15.3
47.5	13.2	13.3 14.6	14.7 16.3	16.4 17.5	17.6
42.5	14.1	14.2 15.7	15.8 17.4	17.5 18.7	18.8
37.5	14.3	14.4 15.9	16.0 17.6	17.7 19.0	19.1
32.5	13.0	13.1 15.2	15.3 16.4	16.5 17.4	17.5
27.5	9.2	9.3 11.5	11.6 12.8	12.9 14.2	14.3
22.5	5.0	5.1 6.4	6.5 7.6	7.7 8.5	8.6
17.5	-0.7	-0.6 0.5	0.6 1.8	1.9 3.0	3.1
12.5	-6.9	-6.8 -5.1	-5.0 -3.8	-3.7 -2.4	-2.3

Period 21-25 Month November Years 45,46,47,49,50,51

LAT.	MB	B	N	A	MA
67.5	1.4	1.5 3.3	3.4 5.6	5.7 7.1	7.2
62.5	2.0	2.1 4.6	4.7 7.1	7.2 8.8	8.9
57.5	5.3	5.4 7.6	7.7 9.5	9.6 11.6	11.7
52.5	9.9	10.0 11.7	11.8 13.5	13.6 15.1	15.2
47.5	13.1	13.2 14.7	14.8 16.1	16.2 17.4	17.5
42.5	15.6	15.7 16.9	17.0 18.4	18.5 19.9	20.0
37.5	16.3	16.4 18.2	18.3 19.7	19.8 21.9	22.0
32.5	13.6	13.7 15.7	15.8 16.8	16.9 18.0	18.1
27.5	11.0	11.1 12.5	12.6 13.5	13.6 14.7	14.8
22.5	5.6	5.7 7.0	7.1 8.2	8.3 9.3	9.4
17.5	0.0	0.1 1.1	1.2 2.3	2.4 3.5	3.6
12.5	-6.6	-6.5 -4.8	-4.7 -3.4	-3.3 -2.2	-2.1

Period 26-30 Month November Years 45,46,47,49,50,51

LAT.	MB	B	N	A	MA
67.5	1.1	1.2 3.1	3.2 5.4	5.5 7.1	7.2
62.5	1.8	1.9 4.3	4.4 7.1	7.2 8.7	8.8
57.5	5.0	5.1 7.3	7.4 9.5	9.6 11.6	11.7
52.5	9.4	9.5 11.4	11.5 13.4	13.5 15.1	15.2
47.5	13.1	13.2 14.6	14.7 16.2	16.3 17.4	17.5
42.5	14.6	14.7 16.0	16.1 17.7	17.8 19.1	19.2
37.5	15.0	15.1 16.5	16.6 18.5	18.6 20.2	20.3
32.5	14.3	14.4 16.1	16.2 17.3	17.4 18.6	18.7
27.5	11.7	11.8 13.1	13.2 14.2	14.3 15.2	15.3
22.5	6.1	6.2 7.6	7.7 8.7	8.8 10.1	10.2
17.5	0.5	0.6 1.5	1.6 2.7	2.8 4.0	4.1
12.5	-6.3	-6.2 -4.6	-4.5 -3.2	-3.1 -1.9	-1.8

TABLE V. (Continued)

CLASS LIMITS FOR HEMISPHERIC ZONAL WIND ANALYSIS
(meters per second)

Period 1-5 Month December Years 45, 46, 47, 49, 50, 51

LAT.	MB	B		N		A		MA
67.5	0.8	0.9	3.8	2.9	5.2	5.3	7.0	7.1
62.5	1.5	1.8	4.1	4.2	7.0	7.1	8.7	8.8
57.5	4.6	4.7	6.9	7.0	9.4	9.5	11.7	11.8
52.5	8.8	8.9	11.0	11.1	13.1	13.2	15.0	15.1
47.5	13.1	13.2	14.6	14.7	16.1	16.2	17.4	17.5
42.5	14.9	15.0	16.3	16.4	17.8	17.9	19.3	19.4
37.5	15.4	15.5	17.0	17.1	18.9	19.0	20.8	20.9
32.5	15.1	15.2	16.6	16.7	17.9	18.0	19.3	19.4
27.5	12.5	12.6	13.8	13.9	14.7	14.8	15.8	15.9
22.5	6.9	7.0	8.3	8.4	9.5	9.6	11.0	11.1
17.5	1.1	1.2	2.1	2.2	3.2	3.3	4.7	4.8
12.5	-5.9	-5.8	-4.3	-4.2	-3.0	-2.9	-1.6	-1.5

Period 6-10 Month December Years 45, 46, 47, 49, 50, 51

LAT.	MB	B		N		A		MA
67.5	0.5	0.6	2.7	2.8	5.0	5.1	6.9	7.0
62.5	1.3	1.4	3.8	3.9	6.9	7.0	8.6	8.7
57.5	4.3	4.4	6.7	6.8	9.4	9.5	11.7	11.8
52.5	8.5	8.6	10.7	10.8	12.9	13.0	14.9	15.0
47.5	13.0	13.1	14.5	14.6	15.9	16.0	17.3	17.4
42.5	15.1	15.2	16.4	16.5	18.1	18.2	19.5	19.6
37.5	15.7	15.8	17.4	17.5	19.2	19.3	21.4	21.5
32.5	15.7	15.8	17.0	17.1	18.3	18.4	19.8	19.9
27.5	13.3	13.4	14.3	14.4	15.3	15.4	16.3	16.4
22.5	7.5	7.6	6.9	8.0	10.1	10.2	11.8	11.9
17.5	1.5	1.6	2.6	2.7	3.8	3.9	5.4	5.5
12.5	-5.6	-5.5	-4.0	-3.9	-2.7	-2.6	-1.3	-1.2

Period 11-15 Month December Years 45, 46, 47, 49, 50, 51

LAT.	MB	B		N		A		MA
67.5	0.3	0.4	2.6	2.7	4.9	5.0	6.8	6.9
62.5	1.2	1.3	3.7	3.8	6.8	6.9	8.6	8.7
57.5	4.1	4.2	6.5	6.6	9.4	9.5	11.7	11.8
52.5	8.4	8.5	10.6	10.7	12.9	12.9	14.9	15.0
47.5	13.0	13.1	14.5	14.6	15.9	16.0	17.3	17.4
42.5	15.4	15.5	16.6	16.7	18.2	18.3	19.6	19.7
37.5	15.9	16.0	17.7	17.8	19.4	19.5	21.7	21.8
32.5	18.1	16.2	17.3	17.4	18.7	18.8	20.2	20.3
27.5	13.8	13.9	14.8	14.9	15.8	15.9	16.8	16.9
22.5	8.0	8.1	9.5	9.6	10.8	10.9	12.3	12.4
17.5	2.0	2.1	3.1	3.2	4.4	4.5	6.1	6.2
12.5	-5.3	-5.2	-3.7	-3.6	-2.4	-2.3	-1.0	-0.9

Period 16-20 Month December Years 45, 46, 47, 49, 50, 51

LAT.	MB	B		N		A		MA
67.5	0.1	0.2	2.5	2.6	4.7	4.8	6.8	6.9
62.5	1.2	1.3	3.6	3.7	6.7	6.8	8.6	8.7
57.5	4.2	4.3	6.5	6.6	9.4	9.5	11.9	11.9
52.5	8.5	8.6	10.5	10.6	12.7	12.8	14.9	15.0
47.5	13.0	13.1	14.5	14.6	16.0	16.1	17.3	17.4
42.5	15.5	15.6	16.7	16.9	18.3	18.4	19.8	19.0
37.5	16.2	16.3	19.0	18.1	19.6	19.7	21.9	22.0
32.5	16.3	16.4	17.7	17.9	19.0	19.1	20.4	20.5
27.5	14.2	14.3	15.2	15.3	16.2	16.3	17.1	17.2
22.5	8.5	8.6	9.9	10.0	11.3	11.4	12.8	12.9
17.5	2.4	2.5	3.6	3.7	4.8	4.9	6.6	6.7
12.5	-5.1	-5.0	-3.5	-3.4	-2.2	-2.1	-0.7	-0.6

Period 21-25 Month December Years 45, 46, 47, 49, 50, 51

LAT.	MB	B		N		A		MA
67.5	0.1	0.2	2.5	2.6	4.6	4.7	6.8	6.9
62.5	1.4	1.5	3.6	3.7	6.6	6.7	8.6	8.7
57.5	4.3	4.4	6.6	6.7	9.5	9.6	11.9	12.0
52.5	8.7	8.8	10.7	10.8	12.9	13.0	15.1	15.2
47.5	13.1	13.2	14.7	14.8	16.1	16.2	17.5	17.6
42.5	15.6	15.7	16.8	16.9	18.4	18.5	19.9	20.0
37.5	16.4	16.5	18.2	18.3	19.7	19.8	21.9	22.0
32.5	16.5	16.6	17.9	18.0	19.1	19.2	20.5	20.6
27.5	14.5	14.6	15.5	15.6	16.5	16.6	17.4	17.5
22.5	9.0	9.1	10.5	10.6	11.8	11.9	13.3	13.4
17.5	2.7	2.8	4.0	4.1	5.3	5.4	7.0	7.1
12.5	-4.8	-4.7	-3.3	-3.2	-1.8	-1.7	-0.4	-0.3

Period 26-31 Month December Years 45, 46, 47, 49, 50, 51

LAT.	MB	B		N		A		MA
67.5	0.1	0.2	2.5	2.6	4.6	4.7	6.9	7.0
62.5	1.5	1.5	3.6	3.7	6.4	6.5	9.7	8.8
57.5	4.4	4.5	6.7	6.8	9.6	9.7	12.0	12.1
52.5	8.9	9.0	10.9	11.0	13.1	13.2	15.2	15.3
47.5	13.1	13.2	14.8	14.9	16.2	16.3	17.6	17.7
42.5	15.7	15.8	17.0	17.1	18.5	18.6	20.0	20.1
37.5	16.5	16.6	18.3	18.4	19.8	19.9	21.8	21.9
32.5	16.6	16.7	18.0	18.1	19.2	19.3	20.6	20.7
27.5	14.6	14.7	15.7	15.8	16.7	16.8	17.7	17.8
22.5	9.3	9.4	10.9	11.0	12.3	12.4	13.7	13.8
17.5	3.0	3.1	4.3	4.4	5.8	5.9	7.4	7.5
12.5	-4.6	-4.5	-3.1	-3.0	-1.4	-1.3	-0.1	0.0

TABLE VI. ANALYSIS OF PROFILES (November 1950)

TABLE VIa. 3-DAY ROLLING AVERAGES

Lat/Day	11	12	13	14	15	16
67.5	7.7	5.9	3.4	2.2	2.5	2.8
62.5	8.6	8.3	8.0	6.4	5.1	3.8
57.5	12.3	13.0	11.7	10.6	9.5	7.7
52.5	15.8	16.3	15.9	15.3	15.3	16.0
47.5	16.2	16.8	17.8	19.3	19.7	20.5
42.5	14.8	14.1	15.8	18.0	20.0	19.9
37.5	12.2	12.8	13.8	15.2	16.6	17.1
32.5	9.8	10.9	10.2	10.4	10.2	11.5
27.5	10.4	11.3	11.7	10.1	8.7	8.3
22.5	6.1	6.0	7.1	6.8	6.5	5.9
17.5	2.5	1	3.6	3.0	2.0	1.4
12.5	-3.8	-4.8	-5.4	-4.0	-3.1	-2.2

TABLE VIb. CLASS DEPARTURERS FROM NORMAL

Lat/Day	11	12	13	14	15	16
67.5	MA	N	B	B	B	B
62.5	A	A	A	N	B	B
57.5	MA	MA	MA	A	N	B
52.5	MA	MA	MA	MA	MA	MA
47.5	N	A	MA	MA	MA	MA
42.5	B	B	N	A	MA	MA
37.5	MB	MB	MB	B	N	N
32.5	MB	MB	MB	MB	MB	MB
27.5	B	N	N	B	MB	MB
22.5	N	N	A	N	N	B
17.5	MA	MA	MA	MA	A	N
12.5	A	N	B	N	A	MA

TABLE VIc. MARKING OF RELATIVE MAXIMA AND MINIMA AND SIGNIFICANT FAST AND SLOW AREAS

Lat/Day	11	12	13	14	15	16
67.5	+					
62.5	+					
57.5	H	+H				
52.5	H	+H	VH	H	H	
47.5	0			H	HV	+HV
42.5		0				H
37.5	0h	h				
32.5	0h	h	h	h	h	
27.5			+			0
22.5		0	+			0
17.5			+H			0
12.5			0			+

three-day rolling averages in terms of departures from normal. Table VIb shows a sample application of this method. Note that while "much above normal" values of the 11th move southward from latitudes 57.5°N and 52.5°N to center at latitude 47.5°N on the 16th, "much below normal" values of the 11th move southward from latitudes 37.5°N and 32.5°N to center on the 16th between 27.5°N and 32.5°N.

"Much above" classes spreading three days horizontally on the tabulation were marked with an "H" at the central day, all "much above" classes spreading vertically over three latitude bands marked with a "V" at the central latitude. Similarly, "much below" classes were marked with either an "h" or "v", as appropriate. Plus (+) marks were used to indicate relative maxima of the three-day rolling averages and zeros (0) to indicate relative minima. This procedure is illustrated in Table IVc.

The complete analytic technique may now be summarized as follows:

(1) Plot the three-day rolling averages of the geostrophic west wind.

(2) Classify each value in terms of its departure from normal.

(3) Mark the relative maxima and minima.

(4) Mark the spatial and temporal extent of extreme classes.

(5) Determine an index cycle description.

Operational analyses of current data will gain needed clarity by smoothing three-day averages once with respect to latitude. An adjustment of class limits will be required, however, with this optional step[1].

Table VII. - A general movement of high velocities can be traced from latitude 52.5° N on the 9th through 47.5° N on the 16th, 37.5° N on the 21st and 22nd, to 22.5° N on the 29th, while a pronounced low velocity trend begins at latitude 67.5° N on the 14th and moves southward through 52.5° N on the 21st to 42.5° N on the 29th. As an instance of secondary systems, note the low-velocity wave which appears at 32.5° N on the 10th and moves through 27.5° N on the 17th before disappearing.

Examination of the data in Table VII revealed that relative maxima and minima occur in any of the five classes of west wind speeds. On the 24th, for example, an MB value at latitude 52.5° N represents a relative maximum, while an MA value for the 28th at latitude 22.5° N must be considered a relative minimum.

The analytic method proposed detects large-scale trends in the geostrophic flow and thus increases information in an index cycle description. Ultimately, detailed knowledge of the variations in westerly speeds should improve the interpretation of surface data. Those synoptic

1. A first approximation of these adjusted limits may be obtained by averaging the limits of Table III once with respect to latitude.

TABLE VII. ANALYZED PROFILE FOR 9 - 30 NOVEMBER 1950

	9	10	11	12	13	14	15	16	17	18	19
67.5	N 5.4	A 7.4	MA 7.7 +	N 5.9	B 3.4	B 2.2 0	B 2.5	B 2.8	B 2.6	B 3.0	N 4.5
62.5	N 5.9	A 7.4	A 8.6 +	A 8.3	A 8.0	B 6.4	B 5.1	B 3.8	MB 1.8	MB 1.2 h	MB -0.7 0 h
57.5	A 10.0 0	MA 11.7	MA 12.3 H	MA 13.0 + H	MA 11.7	N 10.6	N 9.5	B 7.7	MB 4.9	MB 2.1 h	MB 0.4 0 h v
52.5	MA 15.6 H	MA 15.5 0 H	MA 15.8 H	MA 16.3 + H	MA 15.9 H V	MA 15.3 H	MA 15.3 H	MA 16.0	A 14.6	B 11.0	MB 7.8
47.5	MA 17.7 +	A 17.3	N 16.2 0	A 16.8	MA 17.8	MA 19.3 H	MA 19.7 H V	MA 20.5 + H V	MA 19.5 H	MA 17.8	A 16.7
42.5	N 15.5	N 15.6 +	B 14.8	B 14.1 0	N 15.8	MA 18.0	MA 20.0	MA 19.9 H	MA 20.1 H	MA 20.9 H V	MA 21.4 + H
37.5	MB 12.8 h	MB 12.3 h	MB 12.2 0 h	MB 12.8 h	MB 13.8	N 15.2	N 16.6	N 17.1	A 18.1	MA 19.6 +	MA 19.5 H
32.5	MB 10.1 h	MB 10.2 h	MB 9.8 0 h	MB 10.9 h	MB 10.2 h	MB 10.4 h	MB 10.2 h	MB 11.5	B 13.2	B 14.6	B 15.2 +
27.5	B 9.3 h	B 9.3	B 10.4	N 11.3	N 11.7 +	MB 10.1	MB 8.7	MB 8.3 0	MB 9.4	B 10.5	B 10.9
22.5	A 6.3 +	A 6.1	N 6.1	N 6.0 0	A 7.1 +	N 6.8	N 6.5	B 5.9 0	N 6.4	N 6.9	N 7.1
17.5	MA 2.3	MA 2.5 H	MA 2.5 H	MA 3.1 H	MA 3.6 + H	A 3.0	A 2.0	N 1.4 0	A 2.1	A 2.3 +	A 2.2
12.5	A -3.4	MA -2.4 +	A -3.8	N -4.8	B -5.4 0	A -4.0	A -3.1	MA -2.2 +	A -2.9	A -2.6	A -3.3 0

TABLE VII. (Continued)

	20	21	22	23	24	25	26	27	28	29	30
67.5	N 5.8	A 7.1	MA 8.3	MA 9.3 H	MA 11.5 H	MA 13.9 H	MA + 15.1 H	MA + 15.1 H	MA 12.5 H	MA 9.8 H	MA 7.3
62.5	MB 1.5	B 3.6	N 6.7	A 8.8	MA 11.0	MA 13.5 H	MA + 13.9 H	MA 13.1 H	MA 11.1 H	MA 9.5	A 0 8.5
57.5	MB 1.7 h v	MB 3.2	B 5.7	B 6.9	N 7.9	B 7.5	N 8.0	N 9.3	A 10.9	A + 11.0	A 10.5
52.5	MB 5.7 h	MB 0 5.2 h v	MB 5.6 h	MB 7.0 h	MB + 7.2 h	MB 5.7 h	MB 0 5.3 h	MB 7.0 h	MB 9.1	B 10.6	N + 12.0
47.5	N 14.7	MB 13.1	MB 10.5 h v	MB 10.2 h v	MB 8.7 h v	MB 6.8 h v	MB 0 6.0 h v	MB 6.4 h v	MB 8.5 h v	MB 10.2 h	MB 12.3 h
42.5	MA 19.4	N 17.5	MB 15.5	MB 13.9 V	MB 11.7 h v	MB 11.0 h v	MB 11.4 h	MB 10.7 h v	MB 10.5 h v	MB 0 10.2 h v	MB 10.5 h v
37.5	MA 19.3	B 18.0	B 17.7	MB 15.5	MB 0 14.8 h	MB 15.1	B + 15.3	MB 14.5	MB 13.7 h	MB 13.9 h	MB 13.9 h
32.5	B 15.0	B 14.8	B 0 14.5	B 14.8	B 15.7	N 16.3	N + 16.4	B 15.4	B 15.7	B 15.7	B 15.3
27.5	B 11.3	B 11.7	B 12.0	N 13.2	A 14.2	A 14.6	A 14.5 H	A 14.6	A 14.8	A 14.6	A + 15.1
22.5	N 7.3	N 7.3	N 7.2	N 8.1	A 8.9	MA + 9.9 V	A 9.1 V	A 9.2	A 0 8.8	A 9.2 V	A 9.6
17.5	A 2.1	N 2.1	N 0 1.7	N 2.2	N 2.2	MA + 3.8	A 0 2.8	A + 3.4	N 0 2.0	A 3.2	A 3.4
12.5	MA -2.3	MA -2.0 H	MA + -1.9	A -2.7	N -4.7	N -4.4	B -4.7	B -5.8	MB 0 -6.7	MB -6.3	B -4.6

features associated with much-above-normal maxima in a trend may differ appreciably from those associated with maxima of normal intensity and in the case of relatively weak minimal winds may have strikingly divergent consequences. An investigation of these relations is being carried out.

Table VIII. - Table VIII shows values of the seven-year profile average for consecutive fifteen-day periods. Averages for the first half of a month are given under the name of that month, those for the second half in the column labeled no. 2. Departures from normal velocity for the month are indicated by the symbols for each of the five equal classes.

As may be noted, parts of this data are marked by trends having lengthy periods. But of greater significance is the frequency with which class departures from normal carry over from one-half month to the next. Evident also is the lack of similitude between corresponding months of successive years. Compare, for example, the pattern of February, 1946 - normal velocities in the north, above normal velocities in middle latitudes, and below normal velocities in low latitudes - with that of February, 1947 where much below normal velocities appear at high latitudes and much above normal velocities at low latitudes.

Three-day averages of profiles for all 72 months of the historical series (beginning in 1945) have been analyzed at Project AROWA. This

TABLE VIII. HALF-MONTHLY AVERAGE PROFILES WITH DEPARTURES FROM NORMAL

	1945 Oct	2	Nov	2	Dec	2	1946 Jan	2	Feb	2	Mar	2	Apr	2	May	2
67.5	6.1 N	5.5 B	6.0 A	5.9 N	4.7 N	0.9 B	3.3 N	2.5 B	3.8 N	3.3 N	1.8 MB	6.1 N	9.0 A	7.3 N	5.2 A	4.5 N
62.5	9.0 MA	6.5 N	6.9 N	7.4 A	6.0 N	0.6 MB	6.1 A	3.8 B	6.3 N	5.0 N	3.9 B	8.2 A	10.4 A	9.2 A	5.5 A	3.5 B
57.5	9.6 N	10.8 A	9.2 N	8.9 N	6.4 B	2.4 MB	9.9 N	7.4 B	9.2 A	6.5 B	8.4 N	11.1 A	12.4 MA	11.7 A	6.9 A	4.9 B
52.5	10.0 MB	15.2 A	12.9 N	11.7 B	10.0 B	7.7 MB	13.6 N	13.1 N	13.1 A	10.2 N	13.2 MA	14.0 MA	13.2 A	13.0 A	7.2 B	7.6 B
47.5	12.1 MB	18.4 MA	15.3 N	14.2 B	14.1 B	14.5 B	17.3 N	18.1 A	16.5 A	15.2 N	14.8 A	13.7 A	12.9 A	12.7 N	9.0 MB	9.4 B
42.5	11.5 MB	16.8 MA	15.2 B	15.1 B	17.1 N	20.6 MA	19.5 A	20.9 MA	18.9 MA	18.5 A	16.0 A	14.6 N	13.2 N	12.5 B	11.1 B	10.2 MB
37.5	12.5 B	13.6 N	14.9 B	16.3 N	19.3 N	24.5 MA	20.1 A	21.5 MA	20.0 A	20.4 A	17.0 N	16.7 N	13.8 N	12.8 B	13.2 N	12.3 N
32.5	9.9 N	8.7 B	14.2 B	17.3 MA	20.1 A	24.0 MA	20.2 A	20.4 A	20.2 N	21.5 A	18.4 N	17.0 B	14.0 N	11.9 MB	12.3 N	12.5 N
27.5	5.7 N	6.5 N	10.2 B	14.8 MA	16.5 A	18.4 MA	17.2 N	16.7 N	17.8 N	20.1 A	17.5 A	15.0 B	12.4 N	10.5 B	10.3 A	10.2 A
22.5	0.6 B	2.0 N	5.2 B	10.3 MA	9.3 B	9.3 B	10.0 MB	9.2 MB	11.8 MB	15.1 N	14.7 A	9.0 MB	8.3 N	6.8 B	4.4 N	4.3 N
17.5	-0.5 A	0.6 MA	0.3 N	3.5 MA	3.6 N	3.1 B	3.1 MB	2.1 MB	3.3 MB	5.2 B	8.8 A	0.8 MB	2.9 N	2.1 B	0.7 N	-0.3 B
12.5	-4.8 A	-6.1 N	-4.8 N	-3.6 A	-0.3 MA	-3.1 N	-4.8 MB	-4.9 MB	-4.6 MB	-1.8 B	-0.4 N	-9.9 MB	-2.4 N	-6.2 B	-7.0 B	-7.6 MB

TABLE VIII. (Continued)

	1946 Jun	2	Jul	2	Aug	2	Sep	2	Oct	2	Nov	2	Dec	2	1947 Jan	2
67.5	3.6 N	3.7 N	4.4 N	5.2 A	5.2 N	5.9 A	4.2 B	3.9 B	5.3 B	7.7 A	7.6 MA	2.7 B	2.4 B	4.8 N	3.2 B	3.6 N
62.5	4.8 A	3.7 N	3.9 N	3.7 B	4.2 N	6.1 MA	5.1 N	4.1 B	6.5 N	9.1 MA	9.8 MA	4.4 B	2.7 B	6.3 N	4.4 N	3.2 B
57.5	7.3 A	7.3 A	5.6 B	6.9 N	7.0 N	8.3 A	7.9 N	7.0 B	9.0 N	11.7 MA	12.2 MA	8.5 N	6.3 B	9.1 N	7.3 B	5.9 E
52.5	9.8 A	11.2 MA	9.5 N	10.4 A	11.1 MA	9.4 N	10.7 N	12.1 A	11.7 B	15.5 MA	14.3 A	14.0 A	10.9 N	11.9 N	12.6 N	9.8 MB
47.5	12.0 MA	12.7 MA	12.1 A	11.5 N	11.6 N	9.8 B	12.2 N	13.7 A	13.7 B	16.2 A	12.8 MB	17.1 A	15.6 N	15.1 N	17.0 N	13.4 MB
42.5	12.1 A	11.1 N	10.4 N	9.2 B	9.7 N	9.0 B	11.4 B	12.0 N	14.3 N	14.9 N	11.7 MB	17.9 A	17.3 N	16.4 B	19.6 A	16.0 MB
37.5	11.5 A	8.5 B	8.4 A	5.8 B	6.1 B	6.9 N	9.3 B	9.4 B	11.2 B	12.6 N	11.5 MB	15.8 N	17.6 B	17.4 B	19.4 N	19.0 N
32.5	8.2 A	4.1 MB	5.5 MA	2.6 N	2.0 B	3.4 N	6.2 N	6.3 N	13.0 MA	10.5 N	10.7 MB	14.0 B	16.6 B	17.3 B	17.8 B	19.5 N
27.5	4.9 N	1.0 MB	2.5 MA	0.0 N	-1.2 B	0.7 A	2.7 N	3.4 A	6.1 N	6.1 N	9.2 MB	11.4 N	14.8 B	16.5 A	16.1 B	17.7 A
22.5	0.3 N	-2.1 MB	-1.4 A	-2.0 N	-4.0 MB	-2.3 N	-1.2 N	-0.1 A	1.4 B	2.0 N	6.1 N	7.5 A	11.2 A	11.8 A	13.1 N	15.6 MA
17.5	-3.2 N	-4.2 B	-4.4 N	-3.9 N	-4.8 B	-3.4 A	-4.0 A	-3.6 A	-2.5 B	—	0.8 N	1.8 A	6.4 MA	7.0 MA	6.2 N	11.2 MA
12.5	-10.5 B	-10.5 B	-8.5 B	-8.4 B	-8.2 N	-7.0 A	-8.1 B	-7.8 B	-7.4 B	—	-2.7 A	-2.7 A	0.1 MA	-3.5 MA	-0.1 A	6.0 MA

TABLE VIII. (Continued)

	1947 Feb	2	Mar	2	Apr	2	May	2	Jun	2	Jul	2	Aug	2	Sep	2
67.5	1.4 MB	-0.5 MB	2.2 MB	4.8 N	4.0 MB	5.4 B	5.7 A	1.9 MB	2.0 MB	3.5 B	1.9 B	4.0 N	3.6 B	6.0 A	4.9 N	9.7 MA
62.5	1.2 MB	-0.1 MB	4.1 B	5.8 N	6.1 B	5.7 MB	4.8 N	3.4 B	2.1 MB	2.9 B	3.9 N	4.6 N	5.0 A	4.6 N	6.2 A	9.9 MA
57.5	1.8 MB	1.9 MB	5.7 B	6.5 B	8.9 N	7.3 B	5.0 B	5.7 N	2.1 MB	3.9 B	7.9 A	5.7 B	7.7 A	6.7 N	10.2 A	9.6 A
52.5	3.4 MB	5.4 MB	7.8 B	10.3 N	12.7 A	11.5 N	9.2 A	9.8 A	6.3 MB	7.9 B	12.0 MA	9.0 B	9.0 B	8.7 B	12.8 A	9.0 B
47.5	7.9 MB	9.1 MB	8.7 MB	14.4 A	15.5 MA	14.6 MA	12.6 MA	13.0 MA	10.2 N	9.9 B	11.4 N	10.9 B	10.4 B	9.5 B	12.8 N	10.1 MB
42.5	15.2 B	12.8 MB	14.6 N	17.5 A	16.3 MA	16.0 MA	13.2 A	13.3 A	13.2 MA	11.9 A	9.0 B	10.6 A	9.7 N	9.3 B	12.1 N	10.4 MB
37.5	21.2 MA	18.6 N	20.5 MA	20.0 MA	15.9 MA	15.5 A	13.7 A	13.0 N	13.7 MA	10.7 A	6.4 B	7.8 A	7.3 N	8.6 MA	8.4 B	9.2 B
32.5	23.3 MA	21.8 A	23.0 MA	20.1 A	14.6 N	14.3 N	12.7 N	11.4 B	11.7 MA	6.7 B	3.6 N	3.6 N	2.9 N	3.7 A	3.5 MB	5.6 B
27.5	21.2 A	21.9 MA	20.8 MA	18.2 A	10.7 B	9.9 MB	9.4 N	7.1 MB	6.5 A	2.2 B	0.9 A	0.6 A	-1.0 B	-0.2 N	0.0 MB	2.3 N
22.5	18.0 MA	19.2 MA	16.0 MA	11.2 N	4.7 MB	3.6 MB	5.1 N	3.8 B	2.0 A	-1.0 B	-1.2 A	-1.9 N	-3.3 B	-3.1 B	-2.0 B	0.0 A
17.5	10.2 MA	12.8 MA	9.0 MA	4.6 B	-1.6 MB	-0.9 MB	1.5 A	0.2 N	-0.9 A	-2.0 A	-3.0 MA	-4.1 N	-6.0 MB	-4.6 N	-4.7 N	-2.8 A
12.5	2.9 MA	6.1 MA	0.7 A	-12.7 MB	-9.4 MB	-7.8 MB	-4.1 A	-5.7 N	-5.8 MA	-6.2 A	-5.2 A	-6.1 N	-6.6 A	-8.5 B	-6.4 N	-5.1 MA

TABLE VIII. (Continued)

	1947 Oct	2	Nov	2	Dec	2	1948 Jan	2	Feb	2	Mar	2			1949 Jan	2
67.5	8.9 MA	6.5 N	1.6 MB	1.7 MB	0.8 B	6.2 A	6.4 A	4.2 N	4.6 N	8.1 A	9.1 MA	7.0 A			10.1 MA	6.0 MA
62.5	8.6 A	5.6 B	3.3 B	1.8 MB	0.3 MB	6.5 N	7.3 A	4.6 N	6.0 N	4.9 N	9.4 A	9.0 A			11.4 MA	10.3 MA
57.5	9.6 N	6.7 MB	7.5 B	5.5 MB	2.5 MB	8.9 N	12.7 A	8.2 N	10.1 A	5.4 B	11.4 MA	12.9 MA			14.0 MA	13.8 MA
52.5	13.1 N	11.0 B	11.0 B	9.9 MB	8.8 B	11.4 N	15.6 A	12.9 N	13.7 A	8.9 B	12.2 A	15.9 MA			13.8 N	15.6 A
47.5	13.7 B	14.3 B	13.9 B	15.2 N	15.6 N	15.9 N	18.0 A	17.3 N	15.7 A	13.8 N	12.5 N	15.3 MA			13.1 MB	15.7 N
42.5	12.0 MB	15.1 N	15.4 B	18.0 A	20.1 MA	18.1 N	17.1 B	19.3 A	16.7 N	17.7 A	13.4 B	14.2 N			11.9 B	15.1 B
37.5	10.4 MB	14.7 A	18.0 A	18.7 MA	21.0 A	21.0 A	18.8 N	19.8 N	17.3 B	19.4 N	15.7 B	14.5 MB			13.9 MB	14.9 MB
32.5	7.8 MB	11.4 A	15.8 N	16.7 A	18.3 N	18.5 N	13.3 N	18.6 N	17.7 B	18.4 B	16.8 B	10.5 MB			16.3 MB	16.2 MB
27.5	3.8 MB	7.4 A	10.1 B	11.6 N	13.7 MB	14.0 MB	15.3 B	14.7 MB	16.5 B	17.0 B	13.3 MB	23.1 MA			17.2 N	17.1 N
22.5	0.7 B	3.2 A	4.5 MB	5.3 B	7.0 MB	7.9 MB	10.9 B	10.2 MB	12.5 B	12.3 B	11.1 B	8.5 MB			13.9 N	15.0 A
17.5	-2.6 N	-0.7 A	-0.6 B	1.4 N	2.6 B	0.1 MB	5.6 B	6.7 N	7.0 N	5.4 B	6.7 N	4.8 B			6.4 N	8.1 A
12.5	-4.1 A	-4.4 A	-4.4 N	-3.6 A	-4.5 B	-1.5 A	-2.2 N	1.2 A	0.6 N	2.1 A	0.8 A	-0.5 N	-		-4.0 MB	-0.3 N

TABLE VIII. (Continued)

	1949 Feb	2	Mar	2	Apr	2	May	2	Jun	2	Jul	2	Aug	2	Sep	2
67.5	7.0 A	3.4 N	4.4 N	6.4 N	10.4 MA	8.4 A	5.8 A	2.4 MB	4.1 N	5.0 A	5.8 A	2.9 B	4.9 N	6.3 A	5.8 A	7.2 A
62.5	8.8 MA	8.2 A	6.0 N	4.6 B	9.7 A	9.9 A	9.2 MA	3.3 B	5.4 A	4.4 N	4.9 N	3.9 N	5.5 A	4.7 N	3.2 MB	6.4 A
57.5	11.9 MA	12.0 MA	6.7 B	4.4 MB	8.4 B	10.5 A	11.9 MA	4.8 B	7.9 A	6.4 N	5.6 B	8.1 A	8.0 A	6.4 N	4.7 MB	6.5 B
52.5	14.2 MA	15.2 MA	7.6 B	7.2 B	8.3 MB	10.9 N	11.3 MA	8.2 N	10.1 A	7.4 B	8.0 MB	10.9 A	10.2 A	9.2 N	8.0 MB	9.9 B
47.5	14.6 N	16.3 A	10.5 B	11.4 B	10.5 B	11.7 N	9.4 B	10.4 N	10.2 N	8.8 B	9.8 B	11.8 N	10.6 B	9.9 B	10.4 B	13.2 N
42.5	14.6 B	15.5 B	13.7 B	14.6 N	13.1 N	13.1 N	9.3 MB	11.9 N	10.1 N	8.2 MB	10.2 B	10.0 B	8.4 B	9.4 B	11.2 B	14.5 MA
37.5	16.9 B	16.7 MB	18.4 A	17.3 N	15.9 MA	13.9 N	11.3 B	12.9 N	10.5 N	9.2 B	7.8 A	6.1 B	5.4 MB	[illegible].4 N	10.6 N	12.4 A
32.5	18.0 B	18.8 N	21.1 A	18.7 N	16.6 MA	15.1 N	12.8 A	12.5 N	9.7 MA	7.6 N	4.3 A	1.1 MB	2.7 N	4.5 MA	6.6 N	6.8 N
27.5	17.6 N	18.2 N	19.9 MA	17.0 N	16.2 MA	13.5 A	11.5 MA	9.3 N	6.7 MA	4.3 N	0.6 A	-1.0 B	0.6 A	0.8 A	0.7 B	1.3 B
22.5	14.7 N	13.9 N	16.2 MA	13.8 A	12.8 MA	10.2 A	7.7 MA	4.3 N	1.8 A	-0.4 N	-1.8 N	-1.9 N	-0.5 MA	-2.3 N	-2.1 B	-3.7 MB
17.5	8.8 A	4.9 B	8.7 A	8.5 A	7.0 MA	2.8 B	2.4 A	-2.0 MB	-4.2 B	-5.5 MB	-4.8 B	-3.3 A	-4.0 N	-5.0 B	-4.7 N	-7.0 MB
12.5	1.1 A	-2.7 B	-0.8 N	0.9 A	-1.9 A	-4.9 B	-5.0 A	-5.8 N	-9.9 B	-10.8 MB	-9.1 MB	-8.3 B	-9.0 B	-10.2 MB	-7.4 N	-11.6 MB

TABLE VIII. (Continued)

	1949 Oct	2	Nov	2	Dec	2	1950 Jan	2	Feb	2	Mar	2	Apr	2	May	2
67.5	8.3 A	6.0 N	4.1 N	1.8 MB	5.2 A	-1.1 MB	0.3 MB	4.7 N	3.0 B	6.8 N	4.5 N	7.0 A	7.8 N	6.5 B	3.7 N	7.8 MA
62.5	8.7 A	6.8 N	5.1 N	3.9 B	6.8 N	1.5 B	4.3 N	2.9 B	3.2 B	7.7 A	3.6 B	7.3 N	8.5 N	5.2 MB	4.9 N	7.1 MA
57.5	11.3 A	10.5 A	7.9 B	7.9 B	9.4 N	8.0 N	8.3 N	4.7 MB	6.6 B	8.4 N	5.1 B	7.1 B	11.0 A	5.6 MB	6.1 N	7.2 A
52.5	13.6 N	14.6 A	12.9 N	12.5 N	13.0 A	14.4 A	12.8 N	9.5 MB	11.8 N	11.4 N	8.7 B	8.3 B	12.7 A	8.9 B	9.6 A	8.8 N
47.5	14.2 B	15.7 N	15.7 N	16.8 A	14.7 N	17.0 A	16.0 N	14.4 B	16.4 A	16.1 A	13.7 A	12.1 N	12.4 N	12.6 N	12.1 A	10.4 N
42.5	13.1 B	14.6 N	16.8 N	18.5 N	16.7 N	17.9 N	17.6 N	18.1 N	18.1 A	18.6 MA	16.7 A	15.9 A	12.2 B	14.0 A	12.9 A	11.2 B
37.5	12.2 B	12.9 N	16.4 N	18.4 A	17.1 B	17.3 B	17.9 B	18.9 N	18.6 N	18.4 N	20.1 MA	19.1 A	12.6 B	12.7 B	12.2 B	11.3 B
32.5	8.3 B	11.9 A	14.0 B	15.0 N	16.9 B	17.2 B	17.5 B	18.8 N	18.1 B	18.8 N	19.8 A	19.1 N	13.5 B	11.5 MB	10.8 B	10.6 B
27.5	4.6 B	7.9 A	9.7 B	13.0 A	14.8 B	15.6 N	17.1 N	16.5 N	16.3 B	16.4 B	17.6 A	15.1 B	13.9 A	10.4 B	8.4 B	8.1 B
22.5	0.8 B	2.4 N	4.2 MB	6.6 N	10.1 N	11.9 A	14.0 A	13.7 N	12.7 B	13.0 B	12.1 N	9.8 B	10.6 A	8.0 N	6.3 A	4.5 N
17.5	-3.6 B	-4.5 MB	-2.4 MB	-1.0 B	3.1 B	3.6 N	7.7 A	6.4 N	7.1 N	5.6 B	4.7 B	3.3 MB	6.4 MA	4.6 A	3.2 MA	-1.1 B
12.5	-10.4 MB	-9.1 MB	-8.4 MB	-6.1 B	-5.5 MB	-4.8 B	-1.6 N	0.3 A	1.9 A	-2.4 B	-3.8 B	-5.2 MB	-2.5 N	-2.0 A	-0.7 MA	-5.5 N

TABLE VIII. (Continued)

	1950 Jun	2	Jul	2	Aug	2	Sep	2	Oct	2	Nov	2	Dec	2	1951 Jan	2
67.5	5.5 A	2.6 B	2.7 B	0.3 MB	4.8 N	0.2 MB	2.7 B	4.6 N	5.2 B	4.7 MB	5.2 N	8.4 MA	6.7 A	0.4 B	3.6 N	5.4 A
62.5	6.3 MA	2.6 B	2.1 MB	1.2 MB	4.5 N	2.3 MB	4.9 N	5.4 N	6.4 N	5.1 MB	7.0 N	6.9 N	9.4 MA	2.7 B	3.7 B	5.8 A
57.5	7.9 A	4.6 B	5.0 B	5.6 B	5.6 B	5.9 N	10.0 A	9.6 A	9.3 N	8.2 B	10.0 A	6.4 B	9.9 A	5.7 B	7.7 B	7.2 B
52.5	9.8 A	8.2 B	10.0 N	11.4 A	9.4 N	11.5 MA	14.5 MA	13.2 A	13.3 N	12.4 N	15.2 A	8.8 MB	12.2 N	10.2 B	14.1 N	10.9 B
47.5	10.0 N	11.2 A	13.2 MA	14.1 MA	11.0 N	13.8 MA	14.5 A	14.6 MA	15.3 N	17.9 MA	16.2 N	12.6 MB	12.9 MB	14.9 N	18.0 A	14.9 B
42.5	9.9 B	11.6 A	11.8 MA	11.0 A	8.7 B	12.0 MA	10.9 B	12.9 A	14.6 N	17.0 MA	16.0 N	15.7 N	12.8 MB	17.5 N	20.0 A	18.3 N
37.5	9.1 B	9.7 N	7.4 N	5.8 B	5.5 MB	7.9 A	7.4 MB	11.4 A	13.0 N	15.2 MA	14.3 B	16.6 N	14.3 MB	20.5 A	20.3 A	19.1 N
32.5	7.6 N	6.6 B	2.8 N	0.7 MB	2.1 B	3.4 N	2.7 MB	7.8 A	8.9 B	11.1 N	11.5 MB	14.6 B	16.4 B	20.4 MA	19.5 N	19.7 A
27.5	4.7 N	2.0 B	-1.5 B	-2.6 MB	-0.4 N	0.6 A	0.4 B	3.3 A	3.9 MB	6.7 A	9.4 MB	12.1 A	14.8 B	15.3 N	16.4 N	18.1 A
22.5	0.5 N	-1.8 MB	-2.9 MB	-3.3 MB	-1.7 A	-2.1 N	-1.1 N	-0.7 N	0.4 MB	2.2 N	4.8 B	7.8 A	9.3 B	11.1 A	11.9 B	14.0 A
17.5	-3.3 N	-4.5 B	-4.9 B	-4.1 N	-2.7 MA	-4.8 B	-4.0 A	-4.9 N	-3.2 B	-1.3 A	0.8 N	2.2 A	3.9 N	5.6 A	6.1 N	6.1 N
12.5	-6.7 A	-8.2 N	-4.6 MA	-5.3 A	-6.1 MA	-8.1 N	-4.9 MA	-6.4 N	-6.6 B	-3.9 MA	-4.9 N	-3.7 N	-3.6 B	-2.3 N	2.1 MA	-2.9 B

TABLE VIII. (Continued)

	1951 Feb	2	Mar	2	Apr	2	May	2	Jun	2	Jul	2	Aug	2	Sep	2
67.5	1.9 B	8.4 MA	5.2 N	4.1 N	7.7 N	5.3 MB	4.8 N	4.3 N	4.8 A	6.2 MA	4.8 N	5.3 A	5.2 N	5.5 N	3.9 B	5.9 A
62.5	3.7 B	7.8 A	6.1 N	6.4 N	10.0 A	6.6 B	5.4 A	4.2 B	3.2 B	5.7 A	6.3 A	5.8 A	4.5 N	4.8 N	4.6 B	4.1 B
57.5	8.9 A	10.3 A	7.6 N	8.4 N	10.7 A	5.6 MB	4.4 B	6.1 N	4.3 B	5.9 N	7.2 N	7.7 A	5.4 B	6.5 N	6.0 B	5.1 B
52.5	13.5 A	13.5 A	9.4 N	10.7 N	10.1 B	5.7 MB	5.4 MB	9.8 A	6.9 B	7.1 B	7.6 MA	9.7 N	9.0 B	8.6 B	9.2 B	8.8 B
47.5	16.7 A	15.2 N	11.0 B	12.0 N	8.9 MB	9.1 MB	9.2 MB	11.7 A	8.7 B	8.9 B	8.9 MA	10.3 B	11.8 A	11.4 N	11.2 B	11.2 B
42.5	16.4 N	15.8 N	14.8 N	13.6 B	10.1 MB	13.5 N	12.5 N	12.7 A	10.2 N	9.3 B	9.1 B	8.9 B	10.7 A	10.6 A	12.5 N	13.7 A
37.5	17.5 B	16.9 B	16.3 B	14.8 MB	12.6 B	15.6 A	14.7 MA	12.4 N	12.0 MA	9.6 N	8.6 A	6.8 N	7.2 N	7.4 N	11.3 A	12.5 MA
32.5	19.1 N	16.8 MB	18.3 N	16.3 MB	15.8 A	16.2 A	15.0 MA	11.4 B	9.9 MA	6.5 B	5.7 MA	2.5 N	2.2 B	2.9 N	6.6 N	9.8 MA
27.5	19.2 N	14.5 MB	16.7 N	14.5 MB	14.5 A	13.5 A	12.1 MA	7.4 MB	7.1 MA	4.2 N	1.8 MA	-1.3 B	-1.4 MB	0.5 A	1.8 N	3.9 MA
22.5	14.5 N	12.4 B	14.7 A	13.0 N	12.6 MA	9.5 N	7.7 MA	3.8 B	2.4 A	-1.5 B	-0.3 MA	-2.1 N	-2.6 N	-1.8 A	-1.4 N	0.3 MA
17.5	6.2 B	6.2 B	7.3 A	8.2 A	6.7 MA	3.1 N	3.3 MA	-0.2 B	-0.5 A	-1.2 A	-3.9 N	-4.8 B	-4.2 N	-3.5 A	-5.1 B	-4.9 N
12.5	3.0 MA	-0.5 N	1.4 A	5.2 N	2.2 MA	0.7 MA	-2.4 MA	-6.2 B	-5.5 MA	-6.7 A	-5.0 A	-6.1 N	-6.8 A	-8.1 N	-7.5 B	-6.6 N

TABLE VIII. (Continued)

	1951 Oct	2	Nov	2	Dec	2	1952 Jan	2	Feb	2
67.5	7.1 N	7.6 A	5.9 N	7.8 MA	9.0 MA	4.7 N	7.8 MA	-1.1 MA	4.3 N	6.0 A
62.5	6.9 N	6.5 N	5.6 N	9.6 MA	10.9 MA	8.0 A	10.5 MA	2.7 MA	5.1 N	5.2 N
57.5	7.7 B	8.7 B	8.2 N	11.6 A	14.0 MA	12.7 MA	15.3 MA	8.3 N	6.8 B	3.7 B
52.5	11.6 B	11.6 B	13.3 N	15.4 MA	15.5 MA	15.7 MA	16.0 MA	12.5 N	8.3 B	4.5 MB
47.5	14.0 B	15.2 N	16.3 N	17.2 A	15.0 N	17.7 MA	16.4 N	16.2 N	12.5 B	9.4 MB
42.5	15.1 N	15.6 A	17.9 A	15.5 B	[illegible] MB	18.3 A	16.7 B	19.1 A	16.8 N	14.6 B
37.5	14.0 A	13.4 N	18.0 A	16.1 N	16.0 MB	19.1 N	16.9 B	21.4 MA	21.1 MA	20.6 A
32.5	11.2 N	12.3 A	16.0 A	17.2 MA	17.8 N	17.9 N	16.3 MB	20.8 MA	23.2 MA	22.4 MA
27.5	5.5 B	[illegible] A	12.2 A	13.6 A	14.4 B	15.2 N	15.9 B	15.6 B	21.3 MA	21.3 MA
22.5	1.4 B	3.7 MA	6.7 N	8.0 A	11.9 A	11.7 A	14.0 A	15.6 MA	16.6 A	16.7 A
17.5	-3.2 B	-2.5 N	-0.5 B	0.5 N	3.7 N	4.8 A	7.8 A	4.1 B	8.8 A	7.8 N
12.5	-6.1 N	-6.5 B	-7.8 MB	-6.3 B	-3.4 N	-2.2 A	0.2 A	5.8 MA	0.3 N	3.5 MA

data includes wind speeds, their departures from no[illegible]l, and class limits for analyzing profiles of an entire year. Sim[illegible]pies are available to qualified U.S. research organizations on request.

4. Conclusions

1. Index cycles described by Riehl (1) can be det[illegible]mined objectively and consistently by analysis of large blocks o[illegible]rical data.

2. The analytical method herein set forth [illegible]s major trends of the Riehl type and gives additional inf[illegible]g the comparison of the current profile with [illegible] the five-day period.

3. The variation [illegible] month to the next is less than that between corresponding m[illegible] of successive years.

4. The trend[illegible] show strong continuity from day to day and thus establish the bound[illegible] within which the daily prognosis should fall.

VI. FURTHER INVESTIGATION

The preceding chapters have outlined results of research aimed at producing an objective analysis of patterns of flow at 500 mb. The partial success of this investigation opens several promising areas of study. Some topics which may soon be taken up are discussed briefly in this section.

1. Long Waves

A statistical investigation of long-wave occurrence and development is planned. Relative pattern stability will be determined and movement checked with reference to octant and hemispheric wind profiles.

Studies of the change in wave structure with change in latitude are already under way. The circumpolar vortex appears in only a few forms and ways of characterizing these are being developed.

2. Blocking Analysis

An objective description of the blocking pattern on mean charts will be formulated. The problem of the westward retrogression of blocks is currently under consideration and the varying forms of the pattern are being categorized. Interrelations of blocks, long waves, and zonal westerlies are being examined.

From the study of the space mean charts a few impressions of the behavior of hemispheric flow patterns have become clear. They are included in this section titled "Further Investigation" because some untested hypotheses are included. Statistical examination of these tentative conclusions will be included in the next phase of the research program.

1. The trough over the East Coast of Asia is the most permanent feature of the mean flow. This feature may safely be used as an anchor trough in prognosticating patterns.

2. In the first approximation blocks are symetrical with respect to a north-south line through their center.

3. Near zonal flow with broad flat troughs is commonly observed upstream and downstream from blocks.

4. Weak blocks (Δ N in center less than 40 units) may be counted as two long wave troughs plus a long wave ridge. With more intense blocks long wave counts are not useful.

5. Stable patterns of equal wave length equal amplitude long waves are not observed. Readjustments are always taking place in some area of the hemisphere.

6. All of the long wave features do not progress at the same time. The phrase "chart with progressive long waves" is not to be applied

to the entire hemispheric pattern.

7. Four long waves of almost equal wave length occur. This pattern is very unstable and it should never be forecast to persist.

8. The most stable pattern observed has blocks at 160W and 0°. This can persist for several weeks.

9. The space averaged mean contours approximate Constant Absolute Vorticity Trajectories.

10. Troughs and ridges of very different amplitude and wave length can exist side by side without any apparent energy transformation.

3. Zonal Wind Analysis

Case studies of the formation and break-down of the high index will be multiplied, while analysis of profiles will be placed on a narrowed numerical basis.

4. Surface Analysis

Pressure at latitude-longitude intersections is being read off the complete series of Northern Hemisphere charts. These values will be processed at National Weather Records Center in much the same way as were those from 500-mb charts. Special attention will be given to zonal winds, 24-hour pressure changes, and the relation between surface and 500-mb advectional patterns. It is hoped that, as a result, the emergence of surface systems will be so integrated with other parameters objectively defined as to make possible a more accurate forecasting technique.

The aim of this numerical analysis is to isolate synoptic situations in which the future development may be predicted with certainty. The 500-mb studies conducted thus far have shown considerable promise of results in this direction. It is hoped that surface sequences will show many common features when the upper flow is closely specified.

VII. PROPOSED OPERATIONAL PROCEDURES

This chapter outlines the series of computations involved in analyzing the flow at 500 mb. Knowledge of these computations is essential to forecasting for this level. Data and manpower requirements are included to make it clear that only a few meteorological units need work without these parameters.

Following is the daily procedure at Project AROWA:

1. Data

A careful analysis of a hemispheric 500-mb chart with a scale of 1:40, 000, 000 is the first step. This chart can be transmitted in two sections over facsimile circuits. In recent months the analysis placed on the National Facsimile Circuit at Andrews Air Force Base has been consistently good, and it is from this material that the illustrations in this chapter have been drawn.

Since these charts are prepared just once or twice a day so as to point up stationary features of the circulation, a few hours' delay in reception is unimportant. At AROWA, the forecast made each morning is based on the Andrews analysis for 1500Z of the previous day.

Heights are read to the nearest 50 feet from a grid of 252 points, as shown in Figure (23), a grid proved adequate for identifying elements of the upper flow. A denser grid of 504 points, with heights read to the

nearest 10 feet, is required for computing such terms of the second order as vorticity. In the latter case, it should be recalled that the attainment of an ideal accuracy is made impossible by the sparseness of data in many areas.

2. Blocks and Long Waves

As a second step, the total of height values for each point of a 20° diamond is plotted at the center. Contours are drawn for intervals of 200 feet, with the 184 and 172 isolines colored red. This space-averaged mean chart reveals not only blocks but long-wave troughs and long-wave ridges.

Next, normal height values for the period, as given in Weather Bureau Report No. 21, are space-averaged on the same grid. Daily averages are then assessed in terms of their departure from normal. Results make it easy to gauge the intensity and locate the center of blocks and long-wave troughs and ridges.

Finally, 24-hour differences between daily means are plotted to show what changes in long-wave pattern have taken place.

In summary, then, these charts reveal (1) the location of blocks and long waves, (2) their centers and the numerical intensity of these centers, and (3) recent changes in the mean pattern.

3. Zonal Profiles

The height values read from the daily 500-mb analysis also

furnish the basic data for computing zonal profiles. Average height differences within each belt of latitude are conveniently converted to readings in meters per-second by use of Table IX. Three-day running means are then figured, and analyzed in accordance with the procedure outlined in Chapter V.

4. Short-Wave Analysis

Short-wave troughs and ridges are located by marking lines of sharp curvature in the 500-mb contours. The total tendency field is then determined by subtracting current height values (read on a 252-point grid) from values for the previous day. Trough and ridge lines are transferred to this field.

5. Continuity

Three latitudinal profiles from the space-mean chart are plotted each day. For work with Northern Hemisphere charts, latitudes 35°, 45°, and 60° are quite satisfactory.

6. Example

Results of the recommended program of analysis are illustrated for March of this year (see appendix). The computations and analyses were made by William P. DeLuca, AG3, and Don H. Campbell, AG3, and the finished contours drawn by Anthony F. Davainis, AG3. Only 14 man-hours per day were required. It can be seen, then, that the entire routine

ARITHMETICAL METHODS

In carrying out this procedure certain methods and short cuts have been developed and used in handling the numbers. These methods are listed here for the information of those using the procedure and as an explanation of the numerical values on the charts.

1. Reading:

Heights are read to the nearest 50 feet from the Andrew's Analysis. This analysis has contours for every 400 feet. This requires that intermediate contours be sketched near singular points and in areas of weak gradient.

17,864 feet read as 785
17,722 feet read as 770
18,026 feet read as 805
18,338 feet read as 835

2. Computation of Space Mean:

Heights at the four points of the diamond grid are summed and rounded to three digits, using heights from 1:

17,864 feet read as 785
17,722 feet read as 770
18,026 feet read as 805
18,338 feet read as 835
3,195 sum plotted as 320

Contours are drawn on the mean charts for every 8 numbers from 336. The equivalence of those numbers in standard contours is shown.

336	18,400
328	18,200
320	18,000 etc.

On all mean charts the 18,400 contour and the 17,200 contour are emphasized in red. The 18,400 contour has a statistical relation to the maximum wind at that level and with the 17,200 shows the major flow channel. The 17,200 contour disappears frequently in mid-summer and this value should be revised upward to 17,600 about 1 June.

3. Total Tendency:

The total tendency is plotted in tens of feet with the last number always 5 or zero. On a total tendency chart

5 = 50 feet
10 = 100 feet
15 = 150 feet etc.

Isolines are drawn for every 20 units on the chart. Center tendencies are estimated. Falling tendencies 40-60 and 80-100 etc., are shaded in red. Rising tendencies of the same value are shaded in blue. Zero lines are not drawn.

4. Long Wave Tendencies:

The difference between daily mean heights are plotted at each point. These values range from 0 to about 30. Their meaning in actual height change is:

$$2 = \frac{200}{4} = 50 \text{ feet}$$

$$10 = \frac{1000}{4} = 250 \text{ feet}$$

$$20 = \frac{2000}{4} = 500 \text{ feet}$$

These charts are analyzed for isolines named 0 +5, -5 +10, -10 etc. Centers smaller than 5 are essentially no change; there is a basic indeterminacy of about 2.5 due to numerical processes.

The area between isolines numbered +5 and +10, and +15 and +20 etc., are shaded in blue. The similar areas with falling tendencies are shaded red.

5. <u>Departure From Normal:</u>

The difference in height between the daily mean height and the height from the space averaged normal is plotted. These values range from 0 to about $\pm$ 60. Their numerical meaning is:

$$4 = \frac{400}{4} = 100 \text{ feet}$$

$$+20 = \frac{2000}{4} = 500 \text{ feet etc.}$$

These charts are analyzed for 0, $\pm$ 10 $\pm$ 20 units etc. The area between 0 and +10 and between +20 and +30 are colored blue and the corresponding fall areas in red.

6. <u>Continuity Charts:</u>

The continuity chart is prepared by reading heights along a latitude circle and plotting these heights on a graph with time as one

coordinate and longitude as the other. The normal heights for the month are read from the space averaged normal chart and this line is plotted in green each day. When the actual line is above the normal line the area involved is shaded blue and when the actual line is below the normal line the area is shaded in red.

A vertical line marking the longitude of a location of particular interest is helpful for orientation. Norfolk is indicated in this fashion on the continuity charts presented here.

can be carried out easily in an 8-hour day by two Aerographers' Mates.

All analyses are based on the Andrews 500-mb chart. Examples of this chart are shown in Figures (24) and (25). Height values read were recorded on a computation form (Figure 26) which has sufficient space for the necessary arithmetic steps.

An examination of the March, 1954 charts (see appendix) will show that they portray numerically and more completely than has been possible before the broadscale features of the middle atmospheric flow.

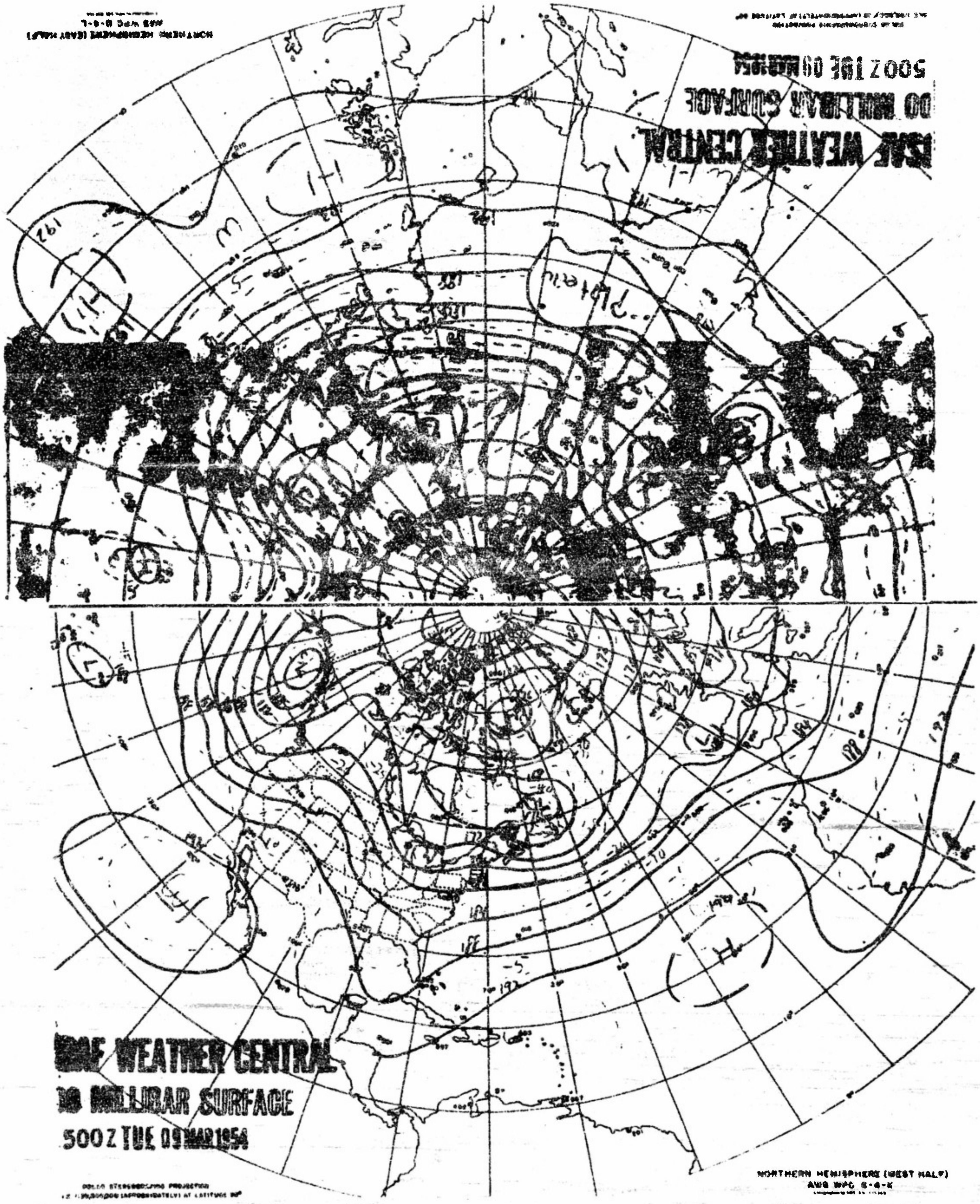


Figure (24). Andrews 500-mb Analysis for 9 March 1954

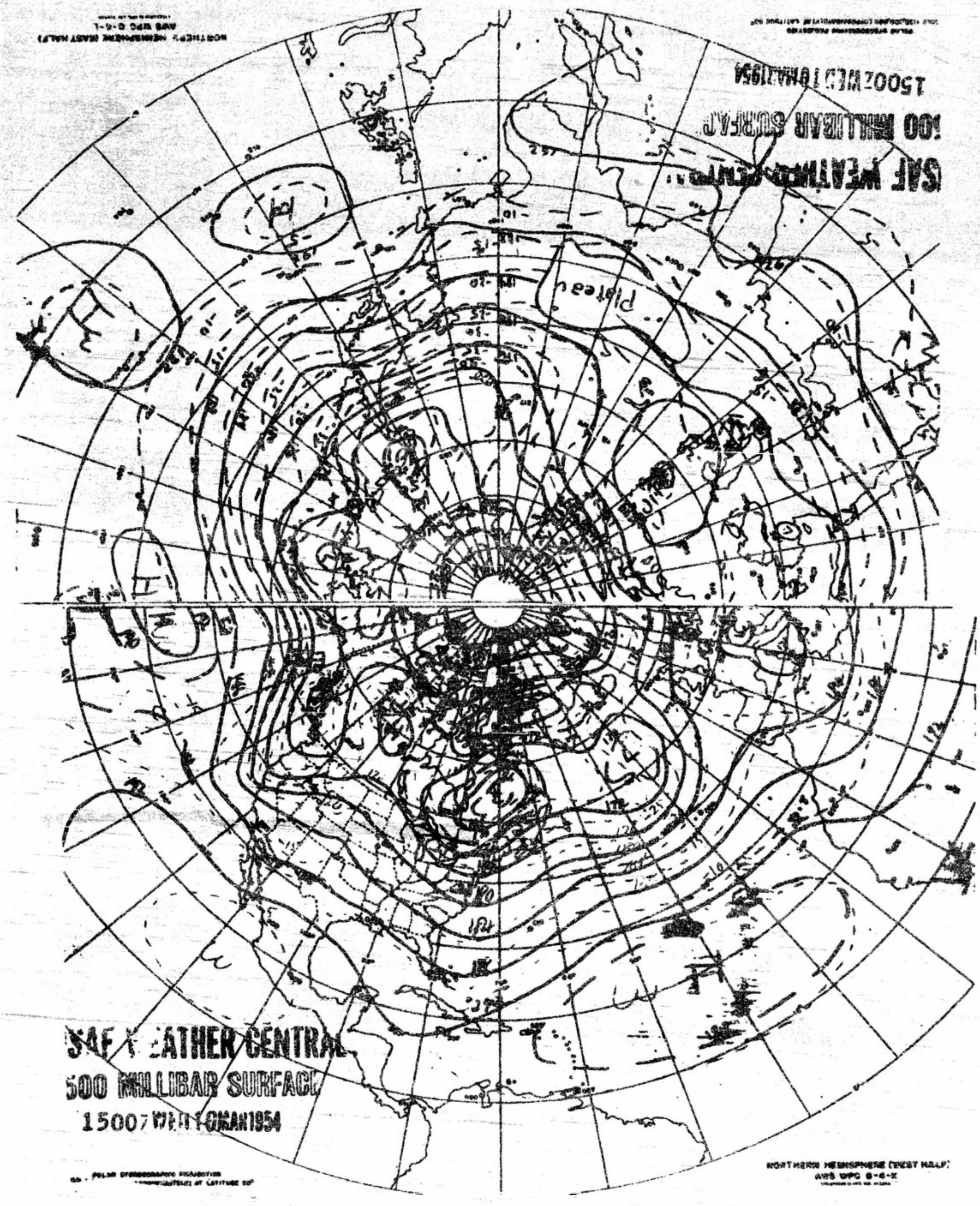


Figure (25). Andrews 500-mb Analysis for 10 March 1954

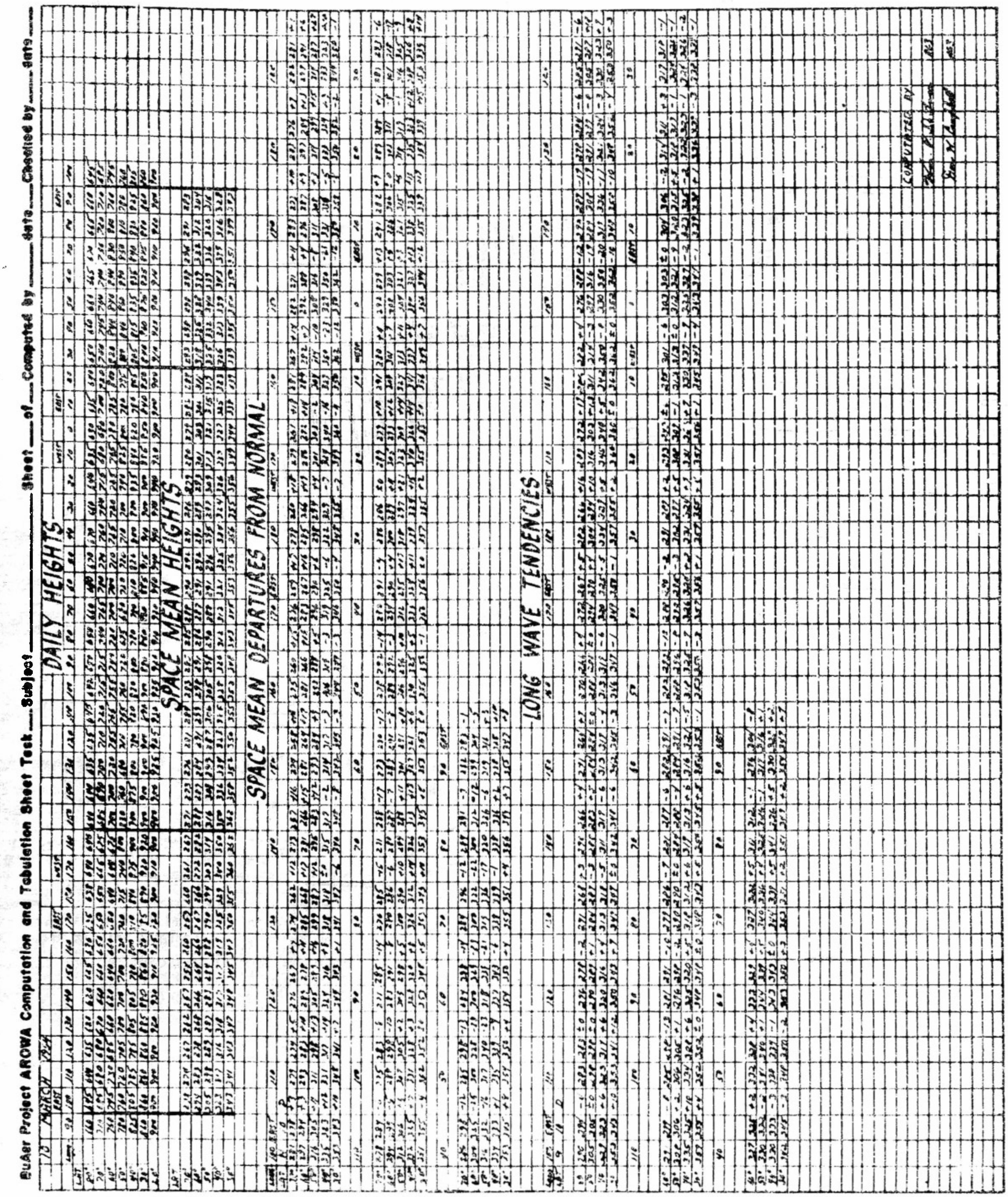


Figure (26). Computation Form

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